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SOME REMARKS ON FRACTAL ANALYSIS OF POLLOCK'S PAINTINGS

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Abstract

A fractal analysis was performed on various paintings by Pollock in order to show some of the challenges that are involved in using this technique in the process of authentification. The reason for using fractal analysis is the fact that Pollock's paintings present a fractal dimension that increases over time and thus could prove valuable in the validation of the date of a specific painting. Based on a modification of traditional Box Counting Method from the HarFA soft using Digital Image Processing with Matlab the various fractal dimensions were obtained. Using different parameters we were able to show the variations that arise in the fractal analysis implying that this technique needs to be accompanied by other methods and is in need of standardization.

Keywords: fractal analysis, painting, Pollock, HarFA

1. Introduction

Many objects in nature display irregular shapes and discontinuous morphogenetic pattern in connection with their functional diversity and seem impossible to describe them rigorously or quantitatively using Euclidean geometry. In recent years fractal anlysis has been revealed a very useful tool for quantitaive description of irregular objects coming from different fields of science [1-4]. A fractal is associated with geometrical objects satisfying two criteria: self-similarity and fractional dimensionality. Self-similarity means that an object is composed of sub-units that (statistically) resemble the structure of the whole object. The fractal dimension is a fractional quantity and it is a direct measure of the relative degree of complexity and roughness of the figure and it can never be greater than the Euclidian dimension of the space where the object is embedded. A lot of art works exhibit fractal geometry from Taj Mahal love memorial in Agra [5] and Eiffel tower in Paris [R.P. Taylor, *The Search for Stress-reducing Fractal Art: From Jackson Pollock to Frank Gehry*, 2006, http://materialscience.uoregon.edu/taylor/human_response/Gehry%28Culture%2

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9.pdf] to Pollock's modern paintings. A number of experimental data showed the existence of fractal structures in archeological patterns and in natural geological media [6, 7]. This information can be used to determine the building material in a perspective of study on degradation and restoration. In addition fractal analysis can be used to study the aging of some art work from cultural heritage. Considering these observations fractal analysis has been used to study the degradation of religious objects from romanian cultural heritage [8]. In painting this procedure has been applied in order to study the clasical and modern art.

One of the most studied artist has been the famous american painter Jackson Pollock Christened as 'Fractal Expresionist' by R.Taylor and coworkers due his 'drip and splash' style of painting [9, 10]. Pollock perfected his technique of painting over ten years and art theorists categorize his art in three phases: a 'preliminary' phase (circa 1943), a 'transitional' phase (circa 1947) and his 'classic' phase (circa 1950). The fractal dimension of his paintings increases from 1 in 1943 to 1.72 in 1952 [11]. Because fractal dimension follows a distinct evolution in time, fractal analysis could be a quantitative method to validate and date the Pollock paintings [12]. Comparing the visual preference tests for natural fractals, Pollock's fractals and computer fractals, the authors found the preferences are maximal for natural fractals with fractal dimension D = 1.3-1.33, for Pollock's fractal having D = 1.5 and for computer fractal having D = 1.5. The art theorists suggested that Pollock painted fractals with high fractal dimension because the visual preference of people is for some fractal like natural fractals. But the fractal analysis of Pollock'paintings is controversial yet. Katherine Jones-Smith and coworkers [K. Jones-Smith, H. Mathur and L. Krauss, *Drip Paintings and Fractal Analysis*, http://arxiv.org/pdf/0710.4917.pdf] argued that Pollock's drip-paintings cannot be usefully characterized as fractals and demonstrated that fractal criteria are not useful for authentication of these paintings.

In this paper we used the fractal analysis for Pollock paintings in order to suggest that the succes of this procedure depends very much on the image preparation.

2. Method

To determine the fractal dimension the modified Box-Counting Method (BCM) method was used. The HarFA soft from Institute of Physical and Applied Chemistry, Brno University of Technology, Czech Republic uses a modification of traditional BCM. By this modification one obtains three fractal dimensions, which characterize properties of black plane DB, black-white border of black object DBW (and this information is the most interesting) and properties of white background DW. The fractal dimension is the slope of the straight line 'Black & White' [O. Zmeškal, M. Veselý, M. Nežádal and M. Buchníček, *Fractal Analysis of Image Structures*, HarFA - Harmonic and Fractal Image Analysis, 2001, 3–5]. This method is, in our opinion, very easy to use and more accurate and can be applied many domains, afterwards in modern art.

To use HarFA soft we prepared the black and white images of the painting using the Digital Image Processing with Matlab. In Thresholding procedure a grey scale image is turned into a binary (black and white) image by first choosing a grey level T in the original image, and then turning every pixel black or white according to whether its grey value is greater than or less than T. The grey images of the coloured paintings have been processed also in Matlab.

3. Results

In this paper one of the last Pollock painting 'Blue poles' from 1952 was analyzed (Figure 1).

Figure 1. The original color 'Blue pole' Pollock's painting [http://en.wikipedia.org/wiki/File:Blue_Poles_%28Jackson_Pollock_painting%29.jpg].

Figure 2. The black and white image of 'Blue poles'.

First we obtained a grey images of the coloured painting 'Blue poles' and then, using Thresholding procedure, we obtained for T >110, the black and white image from Figure 2.

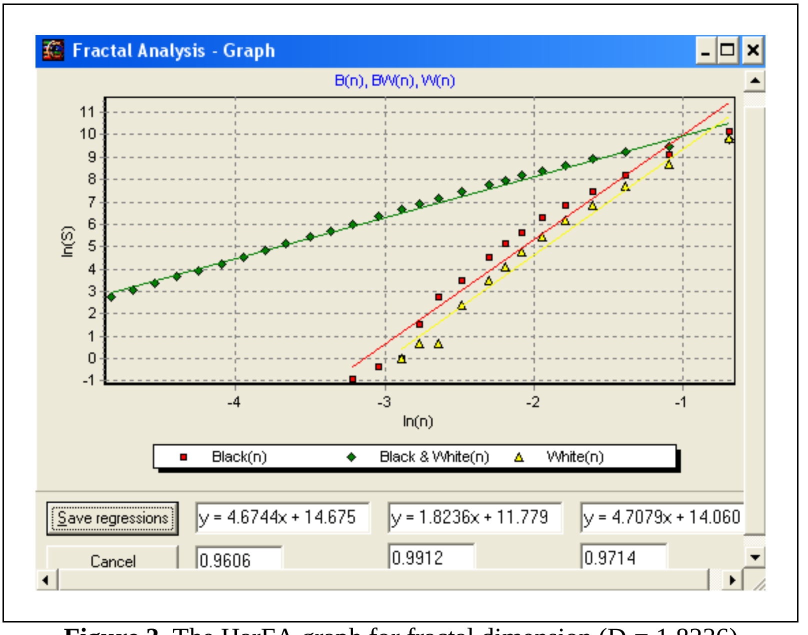


Figure 3. The HarFA graph for fractal dimension (D = 1.8236).

Table 1. Fractal dimension and thershold.

No.	Thresholding, T >	Fractal dimension
1	100	1.8295
2	105	1.8270
3	110	1.8236
4	115	1.8281
5	120	1.8167
6	125	1.8138
7	130	1.7973

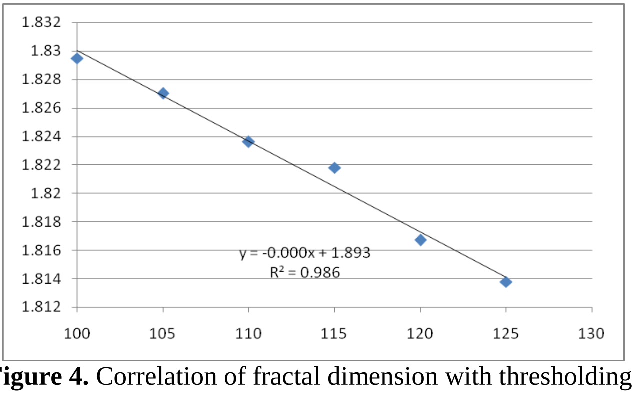
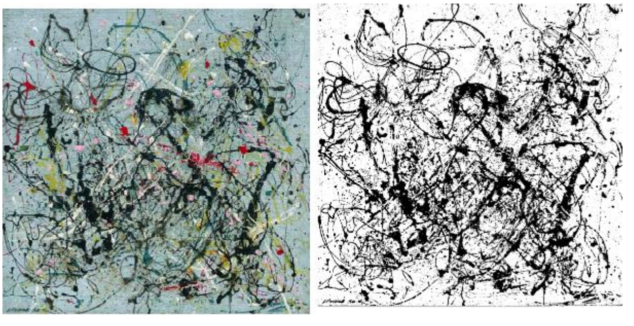


Figure 4. Correlation of fractal dimension with thresholding.

Figure 5. 'Convergence' [http://www.wikiart.org/en/jackson-pollock/convergence-1952].



a

b

Figure 6. 'Number 18' Pollock's painting: (a) the original colour painting, (b) black and white image [13].

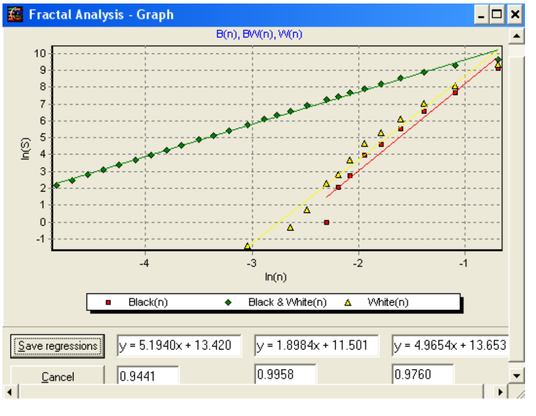


Figure 7. The HarFA graph for fractal dimension of Figure 6b (D = 1.8984).

For this image HarFA soft gives us a fractal dimension D = 1.8236 (Figure 3).

For different values of T we found the values from the Table 1. These values are very well correlated with a correlation factor $R^2 = 0.986$ (Figure 4).

Using T > 130 we investigated the painting ‘Going West’ from 1934-1935 and we found D = 1.3088 and the ‘Untitled’ from 1945 and we found D = 1.7585. For ‘Convergence’ from 1952 (Figure 5), we obtained for T > 130, D = 1.8547.

Afterwards we studied the ‘Number 18’ Pollock’s painting (Figure 6) from Gugenheim in order to compare our method with D’Alessio [13] results on Pollock painting.

For the image b we obtained using HarFA soft a fractal dimension D = 1.8984 (Figure 7).

On the other hand, for ‘Number 18’ using Threholding in Matlab for original colour painting from figure 6a (T > 110), D = 1.8510 was obtained.

4. Conclusions

Fractal geometry has begun to play an important role in the study of Pollack dripped and poured painting. If digital methods are going to be accepted in authentication, related robustness and stability studies must be performed; the fractal analysis involve a great attention because it depends very much on the preparation of the images. Also this menthod is of great importance as it is non-destructive and is very fast. For ‘Blue poles’ the fractal dimension varies from 1.8295 to 1.7973 only due the magnitude of thresholding. This method needs to be accompanied by the analysis of the other elements within the painting: the investigation of pigments using spectroscopic methods like X-Ray difraction, FTIR, Raman spectroscopy, the investigation of the binding media by means of FTIR, Raman or Mass Spectrometry and sometimes even the underlying images using Infrared Reflectography. These analyses have to be performed in order to ensure that the various materials used on the painting correspond to the period when the masterpieces were created confirming or disproving the results obtained by investigating the fractal dimension.

The fractal dimension of Pollock’s painting increased in time, from the earlier work ‘Going West’ (D = 1.3088) to the last ones like ‘Convergence’ (D = 1.8547). Due to the fact that the fractal dimension is a direct measure of the relative degree of complexity of the figure, the fractal dimension of an art work can be regarded as a preliminary indicator of complexity: lower fractal dimensions are a measure of low complexity, while higher fractal dimensions demonstrate high complexity.

To search nature of Pollock’s contribution to modern art means to know how and why he painted fractals, if he knows about fractals before Mandelbrot or not, and so on.

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