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USING GRID MODEL FOR NANO MEASUREMENTS IMAGES

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Abstract : In this paper we will obtain a set of prepared sample images under different conditions, and with different physical properties. These images will be analyzed using the Grid Model (GM). The model starts by converting the prepared sample images (gray scale or colored images) to a two dimensional data files (*.dat) using programming. The 2D data file will be converted to 3D data file using FORTRAN programming. All images will be subjected to the generate filter algorithm for the 3D data file. After filtering the 3D data file we can establish histogram, contours and 3D surface to analyze the image. Another technique will be prepared using Visual FORTRAN for GM, which gives the vector map for the obtained data. In the paper we have proved that, any part from any image can be analyzed without reanalyzing the whole image, all sizes of the images are applicable, three samples with different sizes (256 * 256), (400 * 400), and (510 * 510) are taken (any other sizes are welcome). This method decreases the cost of hardware and sampling.

Keywords- Image processing, Nano measurements images, converting data, Grid model (GD).

I. Introduction

The Scanning Electron Microscope (SEM) remains a main tool for semiconductor and polymer physics but the Transmission Electron Microscope (TEM) and The Atomic Force Microscope (AFM) are increasingly used for minimum size features which called nanomaterial. In addition some physical properties such as micro hardness, grain boundaries and domain structure are observed from optical and polarizing microscope which gives poor information and consequentially the error probability of discussion will be high. Thus, it is natural to squeeze out every possible bit of resolution in the SEM, optical and polarizing microscopes, for the materials under test. In this paper, this problem is going to be tackled using different image processing techniques to get more clear and sufficient information.

Digital image processing analysis and computer visions have exhibited an impressive growth in the past decade in terms of both theoretical development and applications. They constitute a leading technology in a number of very important areas, for example in digital telecommunication, broadcasting medical imaging, multimedia systems, biology, material sciences, Robotics and manufacturing, intelligent sensing systems, remote sensing, graphic arts and printing [1] and [2].

Spectral enhancement relies on changing the gray scale representation of pixels to give an image with more contrast for interpretation. It applies the same spectral transformation to all pixels with a given gray scale in the image. However, it does not take full advantage of human recognition capabilities. Even though, it may allow better interpretation of the image by the user. Interpretation of the image includes the use of brightness information, and the identification of the image features [3].

Spatial enhancement is the mathematical processing of the image pixel data to emphasize spatial relationships. This process defines homogeneous regions based on linear edges. Spatial enhancement techniques use the concept of spatial frequency within the image. Spatial frequency is the manner in which gray-scale values change relative to their neighbors within the image. If there is a slowly varying change in the gray scale in the image from one side of the image to the other, the image is said to have a low spatial frequency. If pixel values vary radically for adjacent pixels, the image is said to have a high spatial frequency [4].

In this research any of the normally dealt with image files with extensions (*.bmp) or tiff are first changed to one with extension (*.dat). Thus, each image is incorporated as a data matrix. Practically, we apply our method on samples in Nanomaterial.

The Grid Model (GM) is an old mathematical tool for numerically finding the minimum value of a function, based on the gradient of that function. GM uses the gradient function (or the scalar derivative if the function is single-valued) to determine the direction in which the function is increasing or decreasing most rapidly. Each successive iteration of the algorithm moves along this direction for specified step size and the gradient is recomputed to determine the new direction to travel [5].

In this paper we will show, the required computations are presented for the Grid Model (GM), and it contains the description of our model (GD). The implementation of the algorithm is illustrated, Statistical analysis is illustrated, The conclusions and further work .

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II. Gridding Model (GD)

The gradient is a vector operator denoted ∇: $\nabla f = grad\,(f)$ the gradient is given by:

$$\nabla f\,(x,y,z) = \frac{1}{h_1}\frac{\partial f}{\partial x}\,\hat{x} + \frac{1}{h_2}\frac{\partial f}{\partial y}\,\hat{y} + \frac{1}{h_3}\frac{\partial f}{\partial z}\,\hat{z} \qquad (1)$$

The direction of ∇f is the orientation in which the directional derivative has the largest value and $|\nabla f|$ is the value of that directional derivative. Furthermore, if $\nabla f \neq 0$, then the gradient is perpendicular to the level curve through $(x_0\ , y_0)\ if\ z = f\,(x,y)$, and perpendicular to the level surface through $(x_0\ , y_0\ z_0)\ if\ \ f\,(x,y,z) = 0$.

Equation (1) can be generalized the for x_k where: $k = 1, 2, 3, \ldots\ldots\ldots, n$

$$\nabla f\,(\vec{x}) = \left\{ \frac{\partial f\,(\vec{x})}{\partial x_1}\ ,\ \frac{\partial f\,(\vec{x})}{\partial x_2}\ ,\ \frac{\partial f\,(\vec{x})}{\partial x_3} + \ldots + \frac{\partial f\,(\vec{x})}{\partial x_n} \right\} \qquad (2)$$

Applying this function on file of data for the piping image of $f(x_1\ , x_2\ ,\ x_3)$, recall that the gradient vector in (2) points locally in the direction of great rate of increase of $f\,(\vec{x})$. Hence, $-\nabla\ f\,(\vec{x})$ points locally in the direction of greatest decrease $f\,(\vec{x})$. Starting at the point $\vec{p}_0$ and searching along the line through $\vec{p}_0$ in the direction $\vec{s}_0 = -\nabla\ f\,(\,\vec{p}_0\,)\ /\left\| -\nabla\ f\,(\,\vec{p}_0\,)\right\|$. Hence, will arrive at a point $\vec{p}_1$, where a local minimum occurs when the point $\vec{x}$ is constrained to lie on the line $\vec{x} = \vec{p}_1 + v\,\vec{s}_0$. Since partial derivatives are accessible, the minimization process can be executed using either the quadratic or cubic approximation method [6] and [7] and [8].

Next, $-\nabla\ f\,(\,\vec{p}_1\,)$ is computed and moved in the search direction $\vec{s}_1 = -\nabla\ f\,(\,\vec{p}_1\,)\ /\left\| -\nabla\ f\,(\,\vec{p}_1\,)\right\|$. A sequence, $\{\ \vec{p}_k\ \}_{k=0}$, will be produced and come to $\vec{p}_2$, where a local minimum occurs when $\vec{x}$ is constrained to lie on the line $\vec{x} = \vec{p}_1 + v\,\vec{s}_1$. Iteration will produce a set of points with the property $f\,(\vec{x}_0\,) \succ f\,(\vec{x}_1\,) \succ \ldots \succ f\,(\vec{x}_k\,) \succ \ldots$ if $\lim_{k\to\infty} \mathrm{\bar{p}_k} = \mathrm{\bar{p}}$ then $\mathrm{f}\,(\mathrm{\bar{p}})$ will be a local minimum $f\,(\vec{x})$.

Outline of the Grid Model (GD)

Suppose that $\vec{p}_k$ has been obtained.

Step 1: Evaluate the gradient vector $\nabla\ f\,(\,\vec{p}_k\,)$.

Step 2: Compute the search direction $\vec{s}_k = -\nabla\ f\,(\,\vec{p}_k\,)\ /\left\| -\nabla\ f\,(\,\vec{p}_k\,)\right\|$.

Step 3: Perform a single parameter minimization of $\Phi(v) = f\,(\,\vec{p}_k + v\,\vec{s}_k\,)$ on the interval [0,c],

Where c is large. This will produce a value $v = h_{\min}$ where a local minimum for $\Phi(v)$.

the relation $\Phi(h_{\min}) = f\,(\,\vec{p}_k + h_{\min}\ \vec{s}_k\,)$ shows that this is a minimum for $f\,(\,\vec{p}_k\,)$ along

the search line $\vec{x} = \vec{p}_k + v\,\vec{s}_k$.

Step 4: Construct the next point $\vec{p}_{k+1} = \vec{p}_k + h_{\min}\ \vec{s}_k$.

Step 5: Perform the termination test for minimization, as: Are the function value $f\,(\,\vec{p}_k\,)$ and

$f\,(\,\vec{p}_{k+1}\,)$ Sufficiently close and the distance $\left\|\ \vec{p}_{k+1} - \vec{p}_k\ \right\|$ small enough?

Step 6: Repeat the process.

III.Methods of conversion

Figure (1) the following block diagram: presenting the new method for converting images with different format as *.bmp, *.tif, *.jpg, *.jpeg, *.gif *.png, *.pcx …etc, to digital numbers representing the intensity of colors in the image.

Using different programming codes and Visual Fortran for making transformation on data files as well as, using filters on these data files for denosing the data. In this method, generally the images are converted to digital matrix and processed by using filter.

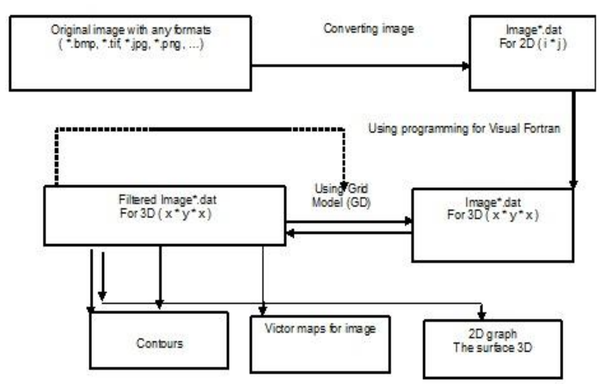

Fig.1 The block diagram presenting Grid Model (GD)

Fig.(1) using the Grid model (GD), which is an old mathematical tool for numerically finding the minimum value of a function, based on the gradient of that function. Grid model uses the gradient function (or the scalar derivative if the function is single valued) to determine the direction in which a function is increasing or decreasing most rapidly, each successive iteration in the algorithm moves along this direction for specified step size and recomputed gradient to determine the new direction to travel. The steps are using programming to convert image from any extension to *.dat file this file is 2D data (i * j). Getting the mages from any resources as digital camera, scanners, and normal- electronic-microscopic or any Nanomaterial, after that converting (by the proposed source code) for gray scale or colored images as: Converts the image x with color map to an intensity image I. ind2gray removes the hue and saturation information while retaining the luminance.

B= ind2gray (xx , map);

Converts the matrix X and corresponding color map to RGB (true color) format.

Step 1: (Input image any formats) Generate an image rows and columns

Step 2: (image file *.dat, 2D data (i * j))

Using Fortran programming for converting 2D data (n * m) to 3D data (x , y , z)

Step 3: Repeated Step 0 and Step1 for any part of the image. (or using programming in Visual Fortran for

Any algorithms)

Step 4: Take the 3D data file after filtering and finding the histogram, contours, 3D surface to analysis the

Image.

After we get the two types of data files 2D data (i * j) , 3D data (x , y , z) we can make compression, transformation …etc.

V. Implementation

We implemented our algorithm for two-dimensional filter using Visual Fortran and the figures have been plotted using, Origin. The filtering looks of high quality since it seems to recover the original sine wave with the add noise totally removed.

For two-dimensional, any of the normally dealt with image files with extensions. (*.bmp) or (*.tiff) are first changed to one with extension. (*.dat). Thus, each image is a data matrix. Practically,

Figure(2), and Figure(3) illustrate a) original image, b) Histogram for the original image, c) The surface 3D, d) The GD, the relation between the Distance (pixels) and Gray value for the original image (25* 256 pixels), and e) The 2D, the relation between the Distance (pixels) and Gray value for the original image.

It should be born in mind that this filtering could be repeated more than one time to obtain the looked for filtering levels.

VI. The Results

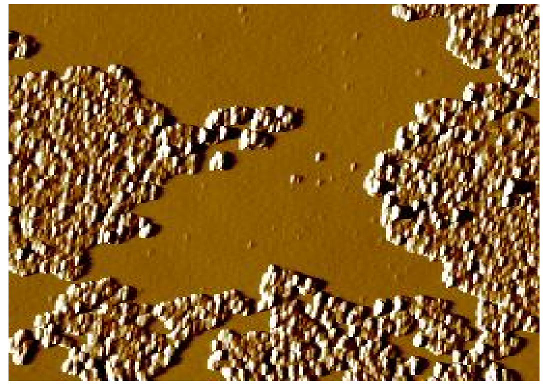

Fig 2.a. Original image (256 * 256 pixels)

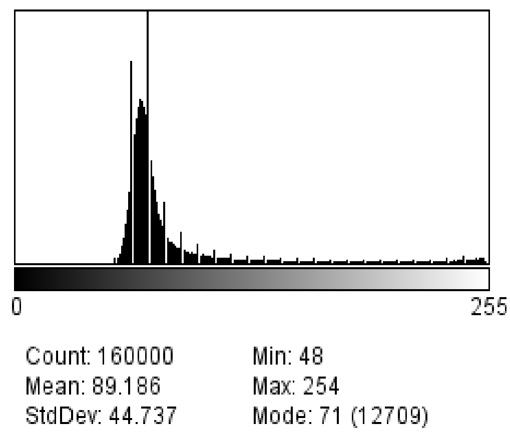

Fig 2. b. Histogram for the original image

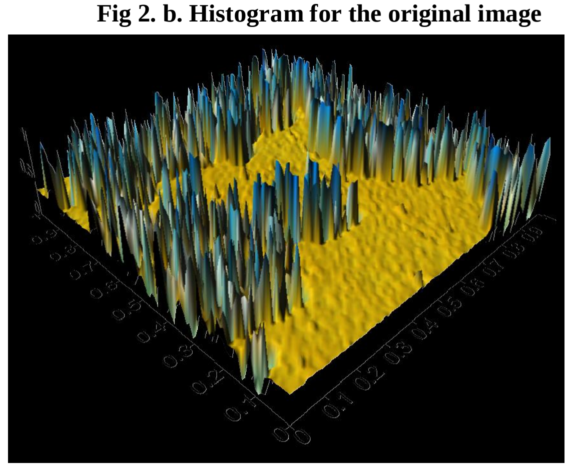

Fig 2. c. The surface 3D for the original image (256 * 256 pixels)

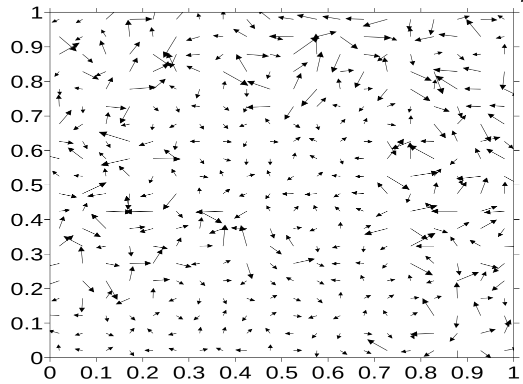

Fig 1. d. The GD and the direction for the original image (256 * 256 pixels)

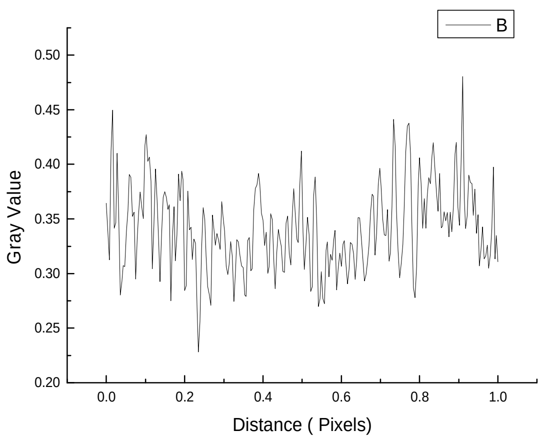

Fig 2. e. The 2D, the relation between the Distance

(pixels) and Gray value for the original image

(256 * 256 pixels)

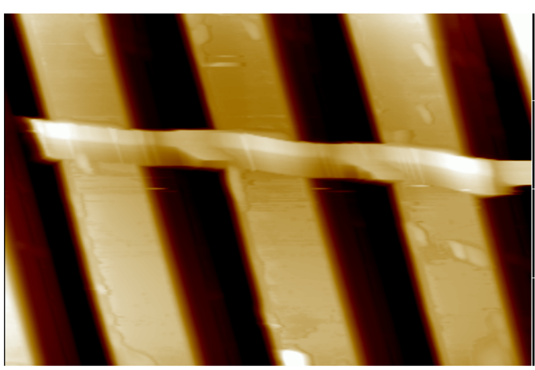

Fig 3.a. Original image (510 * 510 pixels)

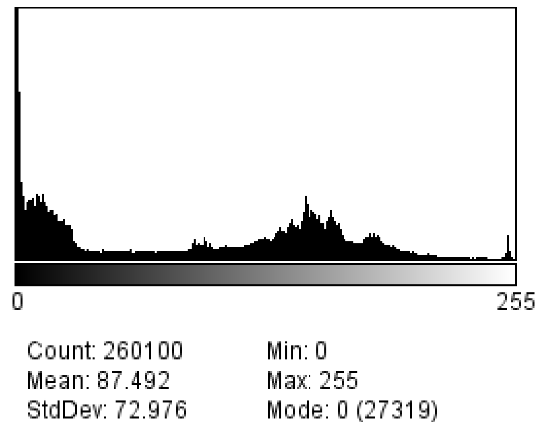

Fig 3. c. Histogram for the original image

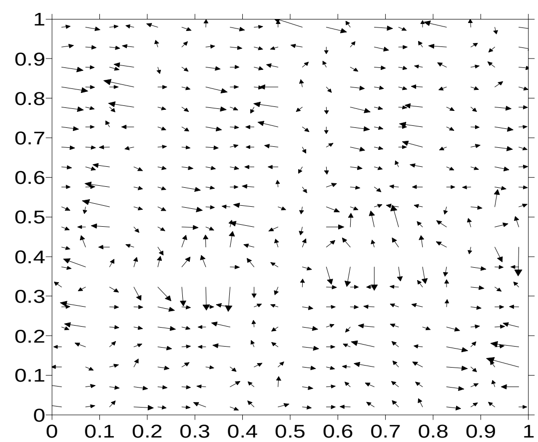

Fig 3. c. The GD and the direction for the original image (510 * 510 pixels)

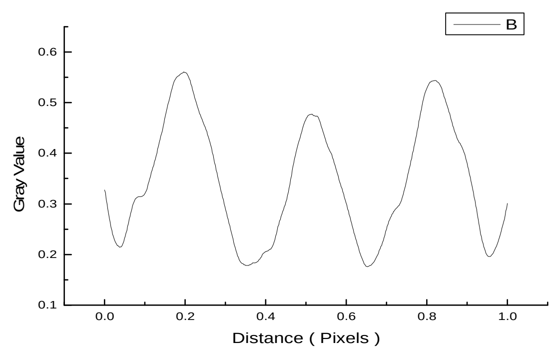

Fig 3. d. The 2D, the relation between the Distance (pixels) and Gray value for the original image (256 * 256 pixels)

After inspecting the up mentioned figures we find that, the (GM) algorithms is the best and gives a considerable

reduction for the costs of processing. Finally, it depends on the programming using Visual Fortran, and Surfer.
From the statistical analysis report we get the mean, median, mode, the linear regression equation to the pixels for the matrix of the data files, the Sum of Squares (SS) and Mean Square (MS).
After the analysis we get the distribution for the three images as below:

VII. Statistical analysis

Univariate Statistics for image a:

	X	Y	Z
Mean	0.500	0.502	0.341
Median	0.501	0.501	0.299
Standard Deviation	0.291	0.290	0.247
Variance	0.085	0.084	0.061
Coef. Variation			0.722
Coef. of Skewness			1.370

Planar Regression: Z = AX+BY+C
Fitted Parameters

	X	Y	Z
Parameter Value	0.015	0.502	0.341
Standard Error	0.003	0.003	0.002

Univariate Statistics for image b:

	X	Y	Z
Mean	0.500	0.500	0.344
Median	0.500	0.500	0.366
Standard Deviation	0.290	0.084	0.081
Variance	0.084	0.084	0.081
Coef. Variation			0.830
Coef. of Skewness			1.161

Planar Regression: Z = AX+BY+C

Fitted Parameters

	X	Y	Z
Parameter Value	- 0.011	0.022	0.339
Standard Error	0.002	0.001	0.001

VIII. Conclusion

In this paper we introduce a method for converting the image format to digital images. And using this method for samples in Nano measurements images, finding any measurements and details in image as histograms contours gird statistical analysis, However, this method can be applied to the image patterns in different ways. Giving different quality of image in each graph. We use the transformation method. Also, this method can be applied in the all Nanomaterial.
We have all statistical results as mean, median, standard deviation, variance, sum of squares (SS) and mean square (MS). Then, the Grid model is a useful tool for digital image processing because it can be applied iteratively.
In the future work we will use NURBS model for find the depth in Nano images or the 3D.

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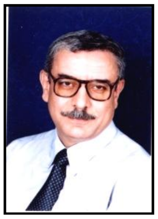

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