Advance method to denoise image by using Cellular Automata method

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طريقة متقدمة لازالة ضوضاء صورة بواسطة استخدام طريقة الماكنه الخلوية

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الخلاصة:-

الماكنة الخلوية هي إحدى الطرق في معالجة الصور وقد ناقشنا في هذا المشروع أزاله الضوضاء في الصور باستخدام الماكنة الخلوية ثنائية البعد, استخدمنا في هذا المشروع طريقتين مقترحة لإزالة الضوضاء في الصور معتمدة على جوار الخلية كما تطرقنا إلى الفرق بين كل الطرق المقترحة من حيث السرعة والكفاءة في إزالة الضوضاء وقد تم تطبيقها على نوعين من الضوضاء هما Gaussianو salt-pepper وتم حساب نسبة الخطأ بين الصور الناتجة .

Abstract:-

Cellular automata can be applied in image processing .in this paper we discuss the application of two –dimensional cellular automata to the problem of noise removal.

The proposed methods compared two new methods that dependent on neighborhoods of cell and given the different between on speed and efficiency to remove image noise, and applied on two type of noise is salt-pepper noise and Gaussian noise and compute error ratio between result images.

1. Introduction:-

The cellular automata (CA) have been used since the forties of last century. It was used in many physical applications .These applications extended to other fields as biological models, image processing, language recognition, simulation, computer architecture, cryptography, and many other fields. [1]
A digital image is a bi-dimensional array of n × n pixels. Each pixel can be characterized

By the triplet (i, j, k) where (i , j) represents its position in the array and k the associated

Color.

The image may be then considered as a particular configuration state of a cellular Automaton that has as cellular space the n £ n array defined by the image. Each site in the array corresponds to a pixel.[2]

We propose a three dynamical rule which hopefully will solve our problem. This rule must beSuch that given a noisy image as initial configuration it produces a trajectory whose finalConfiguration corresponds to a noise-reduced version of the image. It is desirable that theDynamics is applicable to any kind of images without distinction (monochromatic, gray level or color) and applied three proposed methods on two type of noise and compared the different of result between proposed methods.

2. Cellular automata:

CA is a framework of fully discrete universe made of cells. Each cell is characterized by an internal state which typical consists of finite number of bits.

A Cellular Automata consist of one array(one dimensional or two) of cells of which can be one of finite number of possible states, updated synchronously in discrete time steps, according to local, identical interaction rule. The state of cell at the next time step is determined by the current state of surrounding neighborhood of cells. [3]

3. Types of Cellular Automata

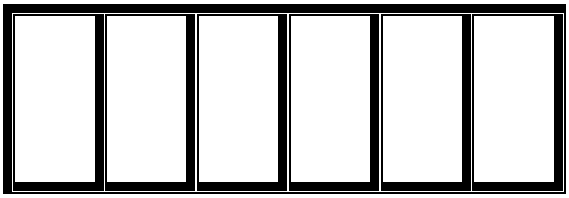
Since its inception, different structural variations of CA have been proposed to ease the design and behavioral analysis of the CA as well as make it versatile for modeling purposes. The CA structure introduced by Von Neumann uses 29 states per cell. Introduced a machine with 8 states per cell . Arbib provided a simple description of self-reproducing CA in .whereas Banks worked with a CA having 4 states per cell [4].

All these **two-dimensional CA** are assumed to have a five-cell neighborhood (self and four orthogonal neighbors). The nine-cell neighborhood CA, with two states per cell and appropriate rules, has been shown to be capable of universal computation. This structure has been utilized with a specified set of local rules to create the game of life. The two variations of neighborhood configurations (five and nine) are termed as Von Neumann and Moore neighborhood, respectively. There are extended generalizations of these two neighborhoods configurations - the Rradial and R-axial neighborhoods respectively]. (For both Von Neumann and Moore neighborhood, R = 1.)

Because of its inherent simplicity, the **one-dimensional CA** with two states per cell became the most studied variant of CA [5].

These cells are arranged in special web a lattice. The simplest one is the one-dimensional lattice mean that all cell are arranged in a line like string such fig (1). The most common CA is built in one or two dimension. Consider the two dimensional Cain fig (2)[5]

Fig (1) one dimensional Cellular Automata



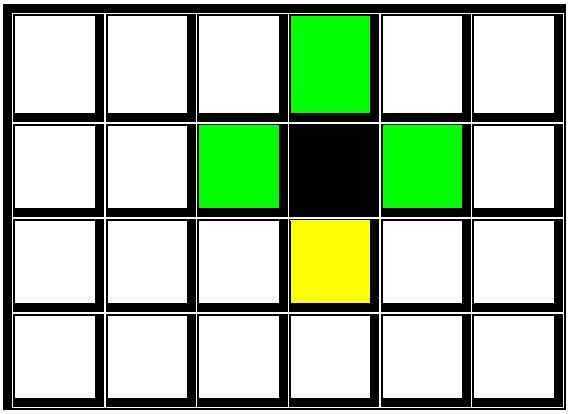


Fig (2) two dimensional Cellular Automata

4. Neighborhoods

We have to add rules, the rule depends on the size and the type of the spatial region in which a cell needs to update its value this region is called neighborhood. In principle there is restriction on the size of the Neighborhood. It's the same for all cells. However in practice .Its often made up of adjacent cells only. If the neighborhood is too large, the complexity of the rule may be unacceptable (complexity usually grows exponentially fast with the number of cells and states in the neighborhood [6].

The one dimensional cellular automata neighborhood three such that fig (1) (the center is original cell and two right and left cells)

Fig (3) the two dimensional neighborhoods

Fig(3) illustrate Neighborhood structures considered for two-dimensional cellular automata. In the cellular automaton evolution, the value of the center cell is updated according to a rule that depends on the values of the shaded cells. Cellular automata with neighborhood (a) are termed ``five-neighbor square''; those with neighborhood (b) are termed ``nine-neighbor square.'' (These neighborhoods are sometimes referred to as the von Neumann and Moore neighborhoods, respectively.) Totalistic cellular automaton rules take the value of the center site to depend only on the sum of the values of the sites in the neighborhood. With outer

totalistic rules, sites are updated according to their previous values, and the sum of the values of the other sites in the neighborhood. Triangular and hexagonal lattices are also possible, but are not used in the examples given here. Notice that five-neighbor square, triangular, and hexagonal cellular automaton rules may all be considered as special cases of general nine-neighbor square rules.[7].

5. Proposed methods:-

In this approach we take two proposed methods to enhancement the image with different noise. The proposed method dependent on neighborhood of the cell and implantation program using Mat lab on original image has size (512×600) pixels.

A(i-1,j-1)		A(i-1,j+1)
	A(i,j)	
A(i+1,j-1)		A(i+1,j+1)

The main idea of these proposed methods is noise is cell has different content of neighborhoods. the proposed methods update value of the each cell dependent of neighborhoods of cell by using average of cells.

The different between three proposed methods is size and ship neighborhoods

The first proposed method using neighborhood like X and size 4 cells such that fig (4).

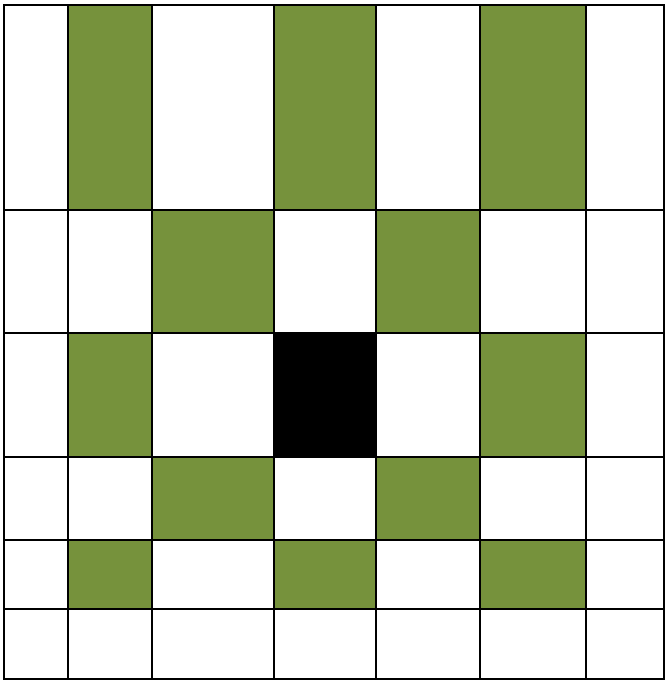
This method updates all cell of image using the equation (1).

$$c(j,i)=(a(j,i)+ a(j-1,i-1) + a(j+1,i-1) + a(j-1,i+1) + a(j+1,i+1))/ 4 \ldots\ldots\ldots (1)$$

Fig(4) the first proposed method

The second proposed method has different neighborhoods ship such that fig (5).this method has size 13 cell and the value of each cell update using the equation (2)

c(j, i)=(a(j, i)+ a(j-1,i-1) + a(j-2,i-1)+ a(j-2,i)+ a(j,i-2)+ a(j+1,i-1) + a(j-1,i+1) + a(j+1,i+1)+ a(j+2,i-2)+ a(j,i+2)+ a(j+2,i-2)++ a(j+2,i)+ a(j+2,i+2))/ 13…….(2)



Fig(5) The second proposed method

6- Root - Mean – Square -Signal -To- Noise Ratio(SNR):

The smaller the value of the error metrics, the better the compressed

image represents the original image. Alternately, with the signal - tonoise

(SNR) metrics, a larger number implies a better image. The SNR

metrics consider the decompressed image $\hat{I}$ (r, c) to be the "signal" and

the error to be "noise". The (SNRRMS) of the output image is defined as

the average of the image [$\hat{I}$ (r, c)]2 divided by the average of [*I* (r, c)]2.

The root - mean - square signal -to- noise ratio as:-

$$SNR_{RMS} = \sqrt{\frac{\sum_{r=0}^{N-1}\sum_{c=0}^{N-1}[\hat{I}(r,c)]^2}{\sum_{r=0}^{N-1}\sum_{c=0}^{N-1}[\hat{I}(r,c)-I(r,c)]^2}} \quad \text{..... 4}$$

Another related metrics, the peak signal -to- noise ratio **(PSNR)**, is defined as

$$PSNR_{PEAK} = 10\log_{10}\frac{(L-1)^2}{\frac{1}{N^2}\sum_{r=0}^{N-1}\sum_{c=0}^{N-1}[\hat{I}(r,c)-I(r,c)]^2} \quad \text{..... 5}$$

Where L = the number of gray levels

(e.g. for 8 bits L = 256) Where *I*ˆ (r, c) and *I* (r, c) are the original picture and its reconstructed version, respectively of size N*N. These objective measures are often used in research because they are easyto generate and seemingly unbiased, but remember that these metrics are not necessarily correlated to our perception of an image [8].

7. The implementation:-

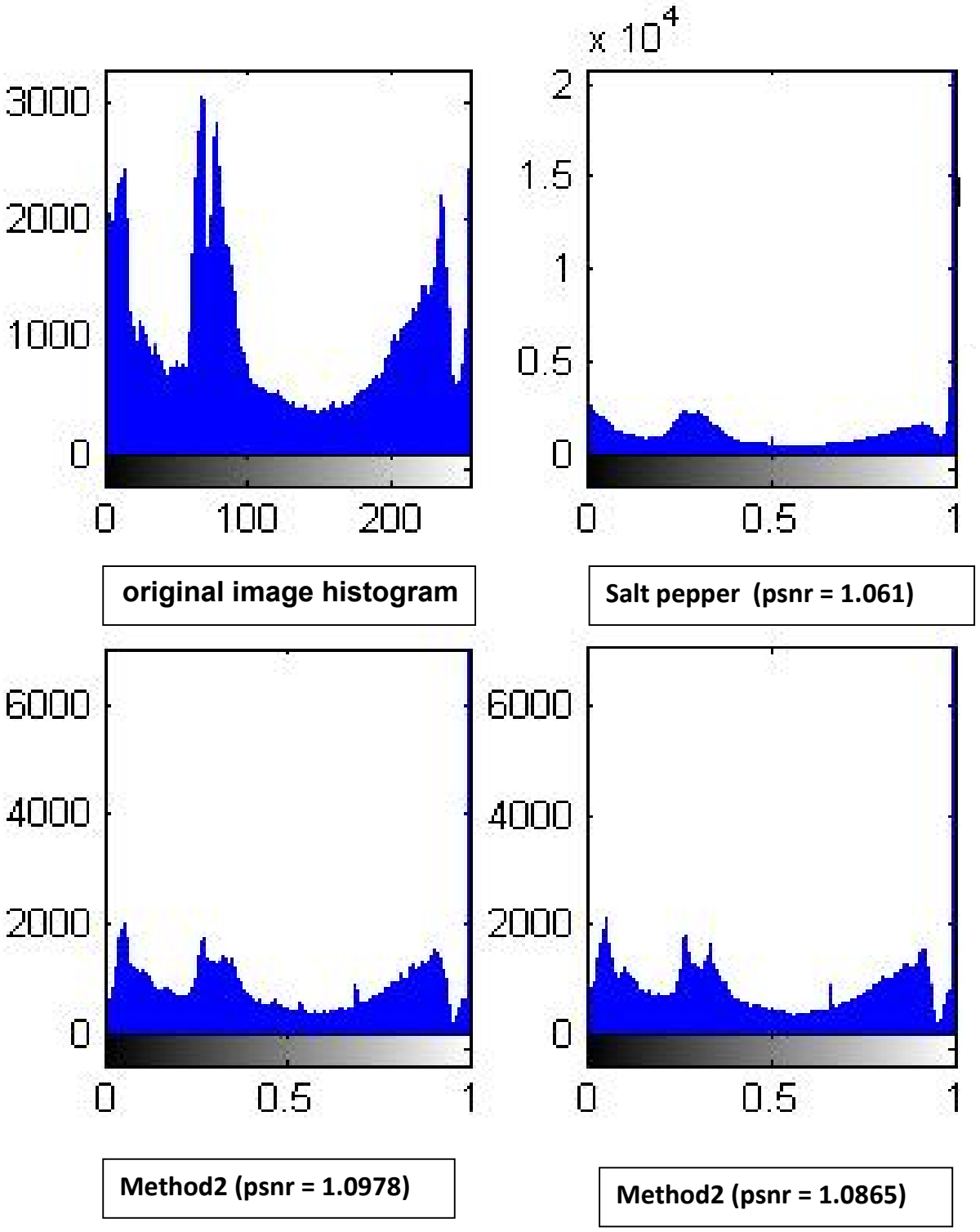
In this paper implantation program using Matlab for read original image has size (512×600) pixel and effect two type noise:-

1- salt-pepper noise and try to enhancement image using three proposed methods such that

afig (7) and fig 8

Fig (7) Enhance image with salt-pepper noise

First proposed method and for speed first proposed is fast than second and proof this results by independent of compute histogram to original image and salt pepper image and to denoise image by methode 1,2 and compute psnr to this images . compare between the result images independent psnr. After compared the results method 2 best than method 1.



gurefi (8):- compare between methods from through compute histogram and psnr with salt pepper noise

2- Gaussian noise:- try to enhancement image using three proposed methods such that fig(9)and fig (10)

Original image

Gaussian image

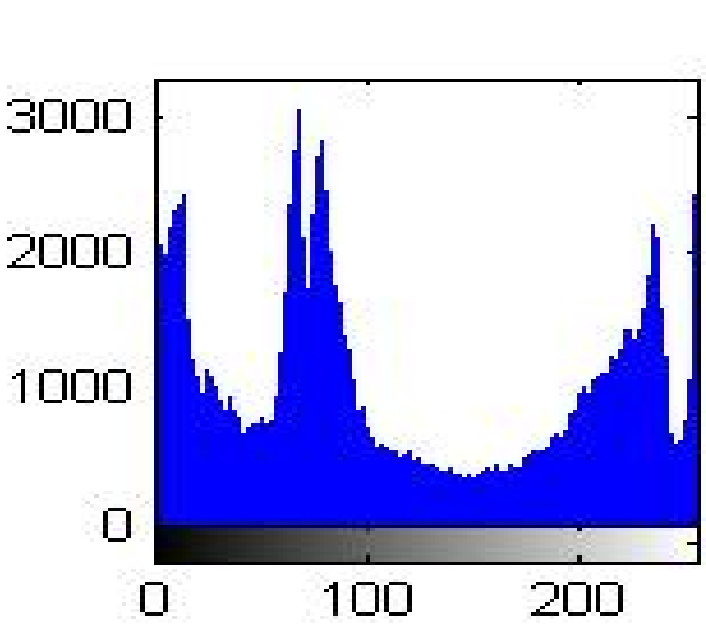
Method 1

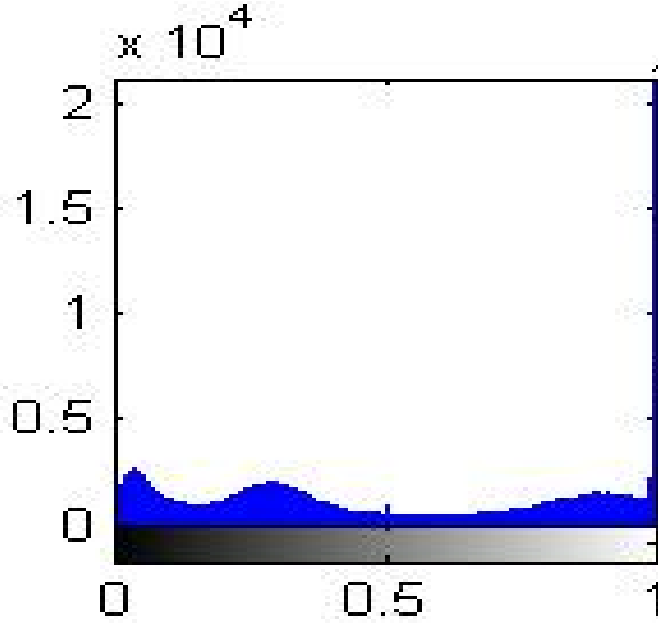
Method 2

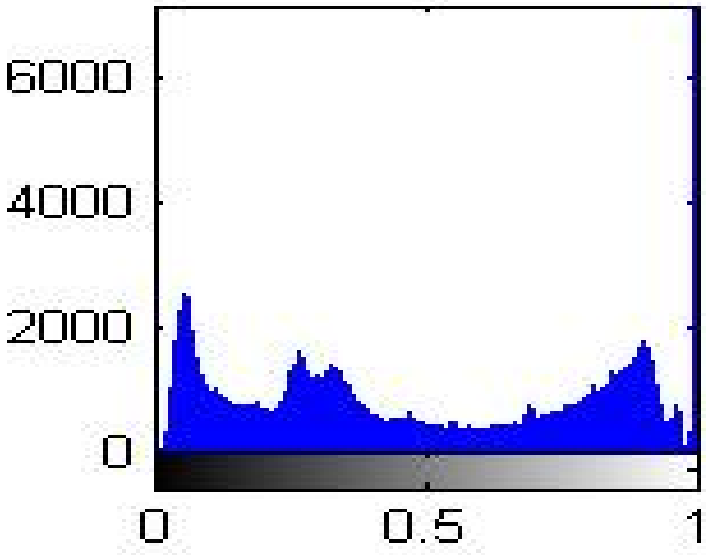
Fig (9) Enhance image with Gaussian noise

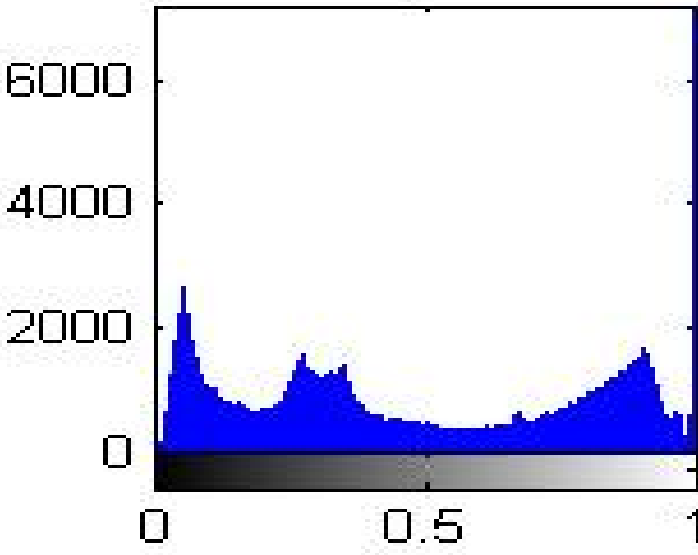
We applied two proposed method on the denoise image The second proposed method is more efficacy than first proposed method and for speed first proposed is fast than second and proof

this results by independent of compute histogram to original image and Gaussian image and to denoise image by methode 1,2 and compute psnr to this images . compare between the result images independent psnr. after compared the resultes method 2 best than method 1.



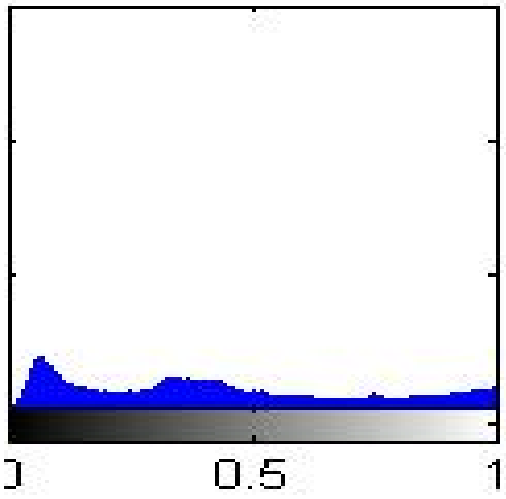


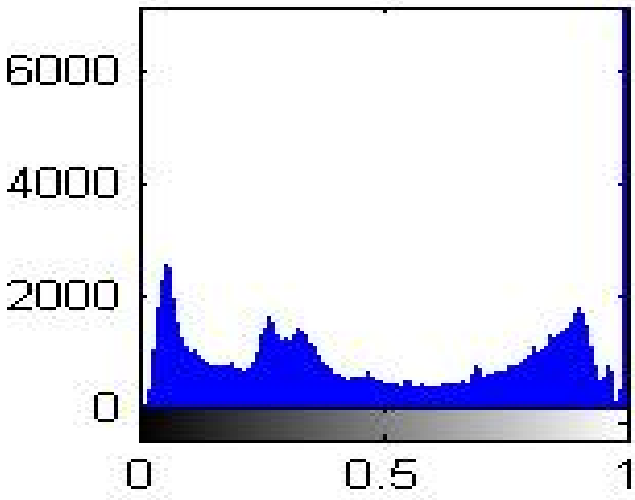




Original image histogram

Gaussian image (psnr= 1.0163)





Method 1 (psnr = 1.0961)	Method 1 (psnr = 1.0845)

gurefi(10) :- compare between methods from through compute histogram and spnr with qaussian noise

7-Conclusion:-

1-cellular automata didn't have complex equation that means is fast and easy used.

2- Proposed methods more effective on Gaussian noise that salt-pepper noise.

3-the second proposed method is best method to remove noise.

4-the first proposed method is faster than other methods.

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