# Texture analysis using spatial gray level dependence matrix and the logical operators for Brodatz images

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## Abstract:

The evaluation of texture features is important for several image processing applications. Texture analysis forms the basis of object recognition and classification in several domains. There is a range of texture extraction methods and their performance evaluation is an important part of understanding the feature extraction tools on the images. in this paper a new algorithm for texture classification based on logical operators and one of the statistical texture methods which is the spatial gray level dependence method. Ten digital Brodatz images used in this search with five samples taken from each image the logical operators have been convolved with texture images and (25) logical operators have been used, (7) textural feature have been obtained from the spatial gray level dependence matrix. These operators have been reduce to (10) logical operators and the features reduced to (3) features depending on the J-parameter, but this is not enough for texture analysis. So the minimum distance has been calculated between the images and the (5) samples belong to them taken into account the logical operators and the features after the minimum distance have been determined the features reduced to (2) and the logical operators to (4). From this result we concluded that the correlation and angular second moment gives the best features and the four logical operators.

**Key words: Textural analysis, logical operators, gray level dependence matrix, textural classification.**

## Introduction:

Texture classification is an image processing technique by which different regions of an image are identified based on texture properties [1].

The classification problem is basically the problem of identifying textured sample as one of several possible texture classes by a reliable but computationally attractive texture classifier. This implies that the choice of textural features should be as compact as possible and yet as discriminating as possible. The extraction of texture features should efficiently embody information about the textural characteristics of the image. Most of textural feature are generally obtained from the application of the logical operators statistical analysis, or measurement in a transformed domain [2].

The texture feature extraction were proposed by Gaussian Markove random field and Gibbs distribution texture models which were developed and used for texture recognition [3]. Logical operators have for Boolean analysis, minimization, spectral layered net work de composition, spectral translation synthesis, image coding. Spectral transformation, adding and arithmetic transforms, logical Hadamard transforms and

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logical operators such as equivalence, negation and conjunction [4]. Initially, texture analysis was based on the first order or second order statistics of textures. The gray-level spatial dependence matrix feature were first proposed by Haralic[5]. Weszk[6] compared texture feature extraction schemes based on Fourier and gray level run length statistics. The gray level matrix features were found to be the best of these features.

## Materials and methods:

It assume that texture information is adequately specified by a set of gray-tone spatial-dependence matrices which are computed for various angular relation ships and distances between neighboring resolution cell pairs on the image all textural features are derived from these angular nearest-neighbor gray-tone spatial dependence matrix [7].

1- Contrast (F1) i-e moment of inertia [8]

$$F1=\sum_{i=0}^{N_g-1}\sum_{i=0}^{N_g-1}(i-j)^2\,p(i,j) \quad \ldots.1$$

2- Inverse difference moment (F2) that is called logical homogeneity

$$F2=\sum_{i=0}^{N_g}\sum_{j=0}^{N_g}\frac{p(i,j)}{(1+(i-j)^2)} \quad \ldots 2$$

3- Correlation (F3)

$$F3=\sum_{i=0}^{N_g}\sum_{i=0}^{N_g}\frac{p(i,j)(i-M_x)(j-M_y)}{\sigma_x\sigma_y} \ldots 3$$

4- Angular second moment is the measure of homogeneity of the image.

$$F4=\sum_{i=0}^{N_g}\sum_{j=0}^{N_g}p(i,j)^2 \quad \ldots.4$$

5-Entropy

$$F5=-\sum_{i=0}^{N_g-1}\sum_{j=0}^{N_g-1}p(i,j)\log(p(i,j))\ldots.5$$

6- Difference variance variance of $P_{x-y}(i,j)\ldots 6$

7- Difference Entropy

$$F7=-i=-\sum_{i=2}^{2N_g}p_{x-y}(i)\log(p_{x-y(i,j)})\ldots 7$$

## Methodology:

The logical operators considered here are of order -2 elementary matrices. The building blocks for defining these matrices are (0,1,-1) matrices of order $(1\times 1)$ [1].

In the present paper the operator masks are first convolved with texture region G(x,y)=F(u,v)$\times$H(u,v)

Where F is the image function and H is one of the set of logical operators. The logical operators considered are of order 2 elementary matrices. The building blocks for defining these matrices are( 0, 1,-1).

$$\underset{AQ1}{\begin{bmatrix}1&1\\1&1\end{bmatrix}}\underset{AQ2}{\begin{bmatrix}1&1\\1&-1\end{bmatrix}}\underset{AQ3}{\begin{bmatrix}1&-1\\1&1\end{bmatrix}}\underset{AQ4}{\begin{bmatrix}1&-1\\1&-1\end{bmatrix}}\quad \underset{BB1}{\begin{bmatrix}1&0\\1&1\end{bmatrix}}\underset{BB2}{\begin{bmatrix}1&1\\1&0\end{bmatrix}}\underset{BB3}{\begin{bmatrix}1&-1\\1&0\end{bmatrix}}\underset{BB4}{\begin{bmatrix}1&0\\1&-1\end{bmatrix}}\underset{BB5}{\begin{bmatrix}1&0\\1&0\end{bmatrix}}$$

$$\underset{C1}{\begin{bmatrix}1&1\\-1&1\end{bmatrix}}\underset{C2}{\begin{bmatrix}1&1\\-1&-1\end{bmatrix}}\underset{C3}{\begin{bmatrix}1&-1\\-1&1\end{bmatrix}}\underset{C4}{\begin{bmatrix}1&-1\\-1&-1\end{bmatrix}}\underset{C5}{\begin{bmatrix}1&0\\-1&1\end{bmatrix}}\underset{C6}{\begin{bmatrix}1&0\\-1&0\end{bmatrix}}\underset{C7}{\begin{bmatrix}1&0\\-1&-1\end{bmatrix}}\underset{C8}{\begin{bmatrix}1&-1\\-1&0\end{bmatrix}}$$

$$\underset{C9}{\begin{bmatrix}1&0\\-1&0\end{bmatrix}}$$

$$\underset{DD1}{\begin{bmatrix}1&1\\0&1\end{bmatrix}}\underset{DD2}{\begin{bmatrix}1&1\\0&-1\end{bmatrix}}\underset{DD3}{\begin{bmatrix}1&0\\0&1\end{bmatrix}}\quad \underset{EE1}{\begin{bmatrix}1&1\\0&0\end{bmatrix}}\underset{EE2}{\begin{bmatrix}0&0\\0&1\end{bmatrix}}\quad \underset{FF1}{\begin{bmatrix}1&0\\0&-1\end{bmatrix}}\underset{FF2}{\begin{bmatrix}0&1\\1&1\end{bmatrix}}$$

The response of the texture image to the operators is used to complete the gray level matrix with seven features. The study images are the Broadatz images which is variable in the internet. Has been used for their homogeneity of texture [9]. Each is of size $(512\times 512)$. Each is split into (5) sub image to increase the number of sample. In this paper (10) Broadaz images is used with (25) logical operators and (7) features obtained from the gray level matrix, also the J-parameter for the ten images are calculated and the average and the stander deviation, at last we calculate the minimum distance between each sample and their image which gives the indication about which features gives the best result.

The (25) logical operators with seven features have been reduced using equation (8) [10].

$$J=\frac{\frac{1}{n}\sum_i \sigma_i}{\frac{1}{\frac{1}{2}n(n-1)}\sum_j\sum_i \left|Avg_i - Avg_j\right|} \quad \ldots.8$$

i,j are the class index, $Avg_i$ and $Avg_j$ are the average value for each sample.

$\sigma_i$ is the stander deviation.

n is the number of classes.

If (J) is small means good features and if the (J) is high, means bad feature discard the feature and logical operators which gives high value of J. for this reason the (25) operators reduce to (10) and the (7) features reduce to (3). The best operator successful with highest No. of features and the best features successful with highest No. of operators. The last operation is to calculate the distance between the five samples and each image of the ten images, the minimum distance between the samples of the same image and the image it self is the best logical operator, the best the feature and the best the bands. Table (1, 2, 3, 4, 5,6,7 and 8) shows the minimum distance for each band. This reduce the operators to (4) and the features to (2).

The minimum distance can be calculated from the equation (9) [10].

$$\text{Dis(a,b)}=\left|\frac{F(a)-F(b)}{\sigma_b}\right| \ldots 9$$

Where F(a) is the value of the sample, F(b) is the value of the image and $\sigma_b$ is the stander deviation of the image.

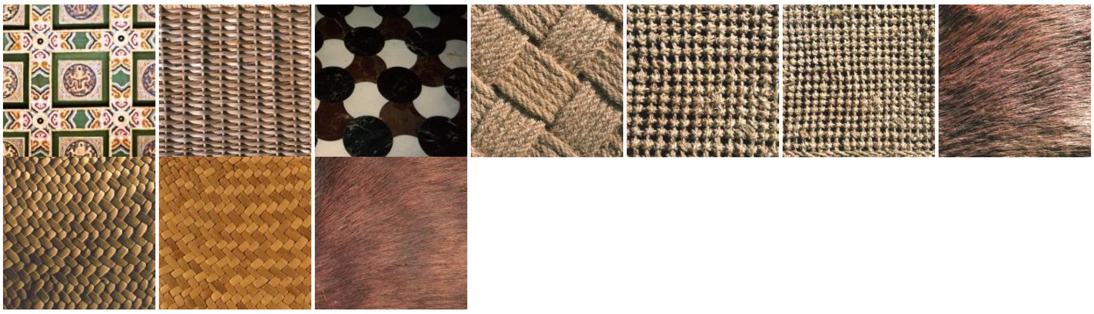

**Fig (1) shows the Brodatz images[11].**

**Table (1) min distance using angular second moment feature with AQ1 logical operator**

Red Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.51 | 0.72 | 1.91 | 2 | 1.12 | 1.81 | 1.45 | 1.27 | 1.89 | 1.23 |
| 2 | 1.71 | 0.11 | 1.91 | 1.81 | 1.01 | 1.35 | 1.77 | 1.16 | 1.33 | 1.19 |
| 3 | 0.13 | 0.81 | 1.74 | 1.81 | 1.31 | 1.13 | 1.31 | 1.71 | 1.87 | 1.21 |
| 4 | 0.99 | 1.6 | 1.12 | 1.71 | 1.8 | 2.12 | 1.51 | 1.11 | 1.9 | 1.91 |
| 5 | 0.21 | 1.73 | 1.01 | 1.91 | 1.02 | 1.01 | 1.31 | 1.94 | 1.96 | 1.98 |

Green Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.51 | 1.81 | 0.81 | 1.91 | 1.98 | 1.77 | 1.35 | 1.97 | 1.99 | 1.88 |
| 2 | 1.82 | 1.91 | 1.91 | 2.52 | 1.51 | 1.95 | 2.97 | 1.99 | 1.93 | 1.19 |
| 3 | 2.23 | 2.00 | 0.94 | 2.98 | 2.91 | 1.53 | 2.94 | 2.36 | 1.98 | 1.86 |
| 4 | 1.89 | 2.91 | 1.11 | 2.01 | 1.97 | 1.02 | 1.73 | 1.99 | 1.1 | 2.00 |
| 5 | 0.98 | 2.08 | 1.98 | 2.81 | 2.97 | 2.91 | 2.95 | 1.76 | 1.08 | 1.96 |

Blue Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.95 | 0.89 | 1.93 | 2.61 | 2.78 | 2.79 | 0.995 | 0.997 | 1.09 | 0.19 |
| 2 | 0.89 | 1.91 | 1.91 | 2.52 | 1.51 | 1.95 | 2.97 | 1.99 | 1.93 | 1.19 |
| 3 | 1.21 | 2.02 | 1.99 | 1.18 | 1.81 | 2.521 | 1.14 | 1.76 | 0.99 | 0.96 |
| 4 | 1.22 | 2.91 | 1.11 | 3.01 | 1.97 | 3.02 | 1.73 | 1.99 | 3.1 | 1.01 |
| 5 | 0.76 | 1.21 | 1.54 | 1.91 | 1.87 | 1.11 | 1.125 | 1.56 | 1.19 | 0.97 |

**Table (2) min distance using angular second moment feature with AQ4 logical operator**

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.51 | 0.72 | 0.91 | 0.21 | 0.10 | 0.70 | 0.35 | 0.71 | 0.89 | 0.33 |
| 2 | 0.61 | 0.01 | 0.90 | 0.28 | 0.21 | 0.25 | 0.97 | 0.26 | 0.19 | 0.92 |
| 3 | 0.53 | 0.12 | 0.85 | 0.32 | 0.51 | 0.13 | 0.41 | 0.81 | 0.87 | 0.31 |
| 4 | 0.88 | 0.63 | 0.21 | 0.70 | 0.81 | 0.12 | 0.81 | 0.31 | 2.9 | 0.21 |
| 5 | 0.12 | 0.65 | 0.14 | 1.01 | 0.02 | 0.01 | 0.32 | 0.67 | 0.21 | 0.93 |

Green Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.67 | 0.64 | 0.18 | 0.77 | 0.43 | 0.56 | 0.31 | 0.71 | 0.93 | 0.89 |
| 2 | 0.12 | 0.32 | 0.63 | 0.87 | 0.24 | 0.87 | 0.54 | 0.76 | 0.21 | 0.72 |
| 3 | 0.51 | 0.68 | 0.35 | 0.71 | 0.82 | 0.66 | 0.45 | 0.34 | 0.45 | 0.86 |
| 4 | 0.87 | 0.32 | 0.43 | 0.21 | 0.87 | 0.34 | 0.12 | 0.23 | 0.73 | 0.12 |
| 5 | 0.33 | 0.12 | 0.73 | 0.76 | 0.84 | 0.32 | 0.21 | 0.90 | 0.52 | 0.78 |

Blue Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.31 | 0.41 | 0.93 | 0.62 | 0.78 | 2.79 | 0.995 | 0.897 | 0.19 | 0.19 |
| 2 | 0.33 | 1.91 | 0.91 | 0.22 | 0.52 | 0.74 | 0.97 | 0.98 | 0.93 | 0.19 |
| 3 | 0.21 | 2.02 | 0.93 | 0.32 | 0.82 | 0.21 | 0.24 | 0.76 | 0.95 | 0.96 |
| 4 | 0.22 | 2.91 | 0.12 | 0.23 | 0.91 | 0.76 | 0.73 | 0.90 | 0.43 | 0.31 |
| 5 | 0.7 | 1.21 | 0.51 | 0.91 | 1.00 | 0.95 | 0.74 | 0.56 | 0.291 | 0.97 |

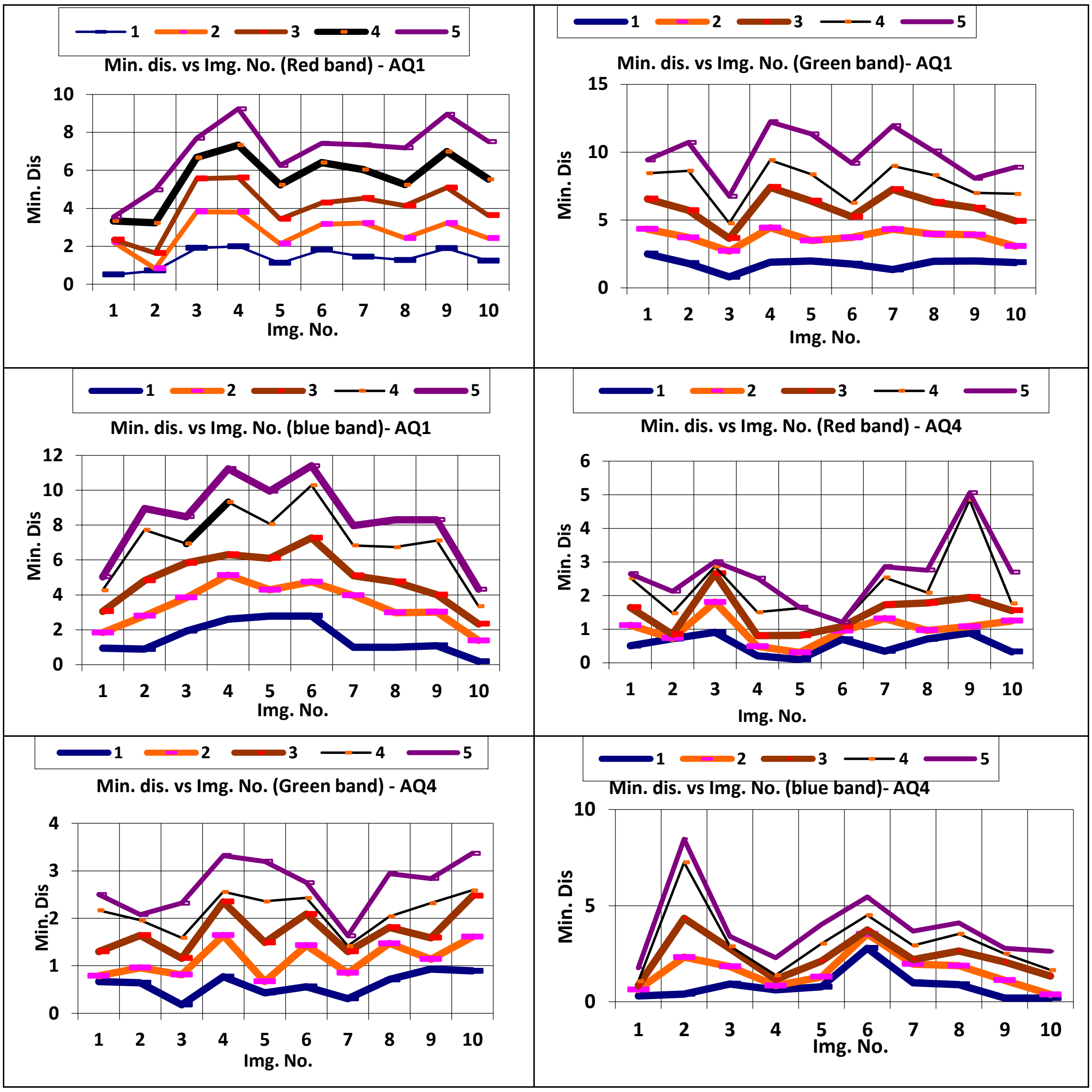


**Fig (2) represented the angular second moment with the AQ1 and AQ4 logical operators.**

**Table (3) min distance using angular second moment feature with BB1 logical operator**

| Red Band | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
| 1 | 0.51 | 0.72 | 0.91 | 0.21 | 0.12 | 0.81 | 0.45 | 0.27 | 0.89 | 0.23 |
| 2 | 0.71 | 0.11 | 0.93 | 0.41 | 0.81 | 0.35 | 0.77 | 2.16 | 0.33 | 1.19 |
| 3 | 0.13 | 0.81 | 0.74 | 0.81 | 0.31 | 0.23 | 2.31 | 0.71 | 0.87 | 0.21 |
| 4 | 0.99 | 0.61 | 0.12 | 2.71 | 0.87 | 0.32 | 0.51 | 0.17 | 0.9 | 0.91 |
| 5 | 0.21 | 0.73 | 0.201 | 3.91 | 0.12 | 0.41 | 3.31 | 0.94 | 2.96 | 0.98 |
| Green Band | | | | | | | | | | |
| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
| 1 | 2.51 | 1.81 | 0.81 | 1.91 | 1.98 | 1.77 | 1.35 | 1.97 | 1.99 | 1.88 |
| 2 | 1.82 | 1.91 | 1.91 | 2.52 | 1.51 | 1.95 | 2.97 | 1.99 | 1.93 | 1.19 |
| 3 | 2.23 | 2.00 | 0.94 | 2.98 | 2.91 | 3.53 | 2.94 | 2.36 | 1.98 | 1.86 |
| 4 | 1.89 | 2.91 | 1.11 | 3.01 | 1.97 | 3.02 | 1.73 | 1.99 | 3.1 | 2.00 |
| 5 | 0.98 | 2.08 | 1.98 | 2.81 | 2.97 | 2.91 | 2.95 | 1.76 | 3.08 | 1.96 |
| Blue Band | | | | | | | | | | |
| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
| 1 | 2.51 | 1.81 | 0.81 | 1.91 | 1.98 | 1.77 | 1.35 | 1.97 | 1.99 | 1.88 |
| 2 | 1.82 | 1.91 | 1.91 | 2.52 | 1.51 | 1.95 | 2.97 | 1.99 | 1.93 | 1.19 |
| 3 | 2.23 | 2.00 | 0.94 | 2.98 | 2.91 | 3.53 | 2.94 | 2.36 | 1.98 | 1.86 |
| 4 | 1.89 | 2.91 | 1.11 | 3.01 | 1.97 | 3.02 | 1.73 | 1.99 | 3.1 | 2.00 |
| 5 | 0.98 | 2.08 | 1.98 | 2.81 | 2.97 | 2.91 | 2.95 | 1.76 | 3.08 | 1.96 |

**Table (4) min distance using angular second moment feature with BB2 logical operator**

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.50 | 0.52 | 0.13 | 0.31 | 0.10 | 0.30 | 0.15 | 0.21 | 0.89 | 0.33 |
| 2 | 0.63 | 0.11 | 0.12 | 0.21 | 0.12 | 0.25 | 0.17 | 0.20 | 0.19 | 0.32 |
| 3 | 0.50 | 0.32 | 0.22 | 0.12 | 0.32 | 0.23 | 0.12 | 0.31 | 0.87 | 0.31 |
| 4 | 0.58 | 0.52 | 0.31 | 0.10 | 0.84 | 0.22 | 0.31 | 0.31 | 0.19 | 0.21 |
| 5 | 0.22 | 0.15 | 0.02 | 0.21 | 0.12 | 0.31 | 0.32 | 0.27 | 0.21 | 0.93 |

Green Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.67 | 0.64 | 0.18 | 0.77 | 0.43 | 0.56 | 0.31 | 0.71 | 0.93 | 0.89 |
| 2 | 0.12 | 0.32 | 0.63 | 0.87 | 0.24 | 0.87 | 0.54 | 0.76 | 0.21 | 0.72 |
| 3 | 0.51 | 0.68 | 0.35 | 0.71 | 0.82 | 0.66 | 0.45 | 0.34 | 0.45 | 0.86 |
| 4 | 0.87 | 0.32 | 0.43 | 0.21 | 0.87 | 0.34 | 0.12 | 0.23 | 0.73 | 0.12 |
| 5 | 0.33 | 0.12 | 0.73 | 0.76 | 0.84 | 0.32 | 0.21 | 0.90 | 0.52 | 0.78 |

Blue Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.31 | 0.41 | 0.93 | 0.62 | 0.78 | 2.79 | 0.995 | 0.897 | 0.19 | 0.19 |
| 2 | 0.33 | 1.91 | 0.91 | 0.22 | 0.52 | 0.74 | 0.97 | 0.98 | 0.93 | 0.19 |
| 3 | 0.21 | 2.02 | 0.93 | 0.32 | 0.82 | 0.21 | 0.24 | 0.76 | 0.95 | 0.96 |
| 4 | 0.22 | 2.91 | 0.12 | 0.23 | 0.91 | 0.76 | 0.73 | 0.90 | 0.43 | 0.31 |
| 5 | 0.7 | 1.21 | 0.51 | 0.91 | 1.00 | 0.95 | 0.74 | 0.56 | 0.291 | 0.97 |

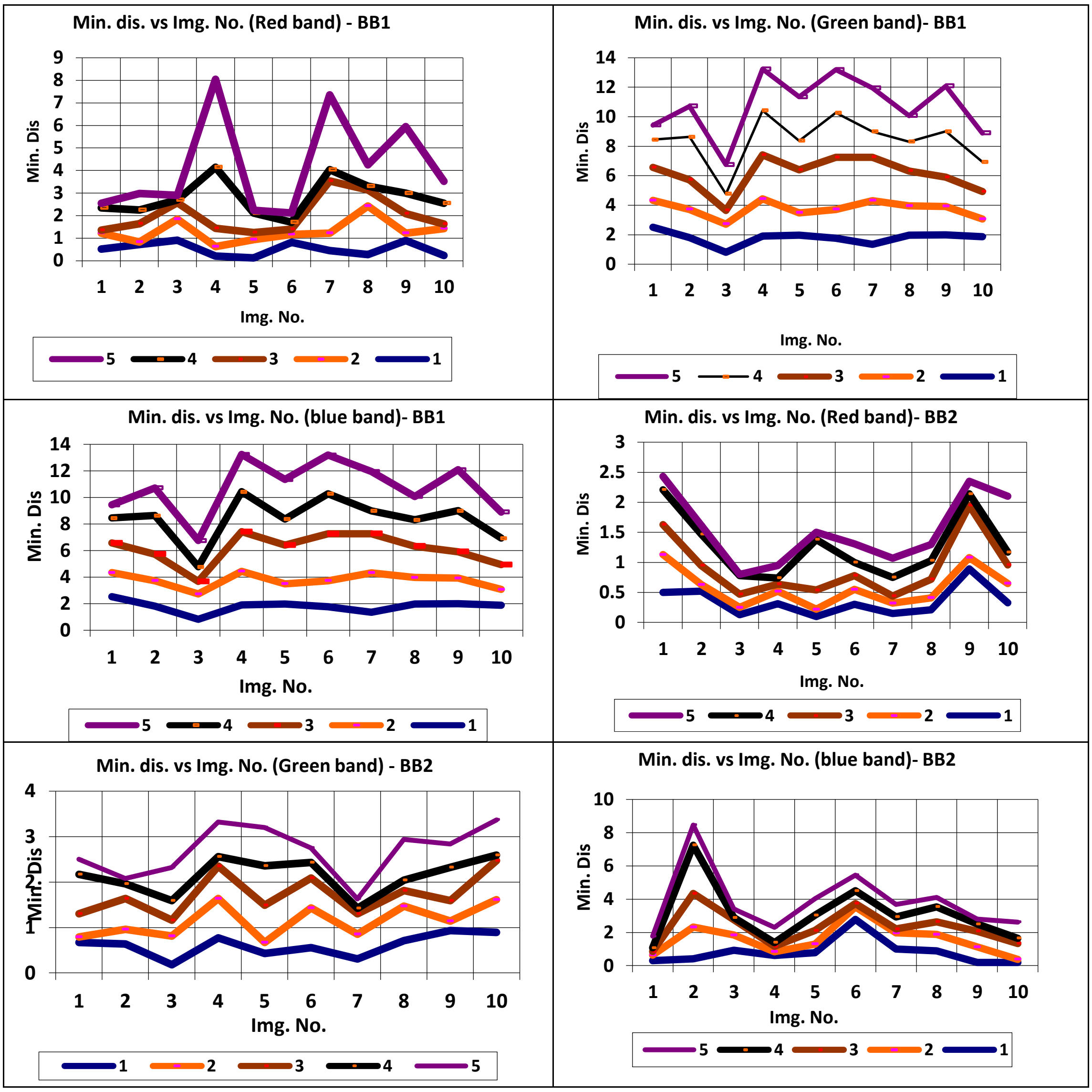


**Fig (3) represented the angular second moment with the BB1 and BB2 logical operators.**

## Table (5) min distance using Correlation feature with AQ1 logical operator

Red Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.51 | 0.72 | 0.92 | 0.21 | 0.12 | 0.83 | 0.25 | 0.27 | 1.19 | 0.23 |
| 2 | 1.71 | 1.11 | 0.91 | 1.81 | 2.01 | 2.35 | 1.77 | 2.16 | 2.33 | 0.19 |
| 3 | 0.13 | 1.81 | 0.74 | 3.81 | 2.31 | 6.13 | 2.31 | 2.71 | 2.87 | 0.12 |
| 4 | 1.99 | 1.6 | 1.12 | 2.71 | 2.8 | 2.12 | 2.51 | 3.11 | 2.9 | 1.91 |
| 5 | 1.21 | 1.73 | 4.01 | 3.91 | 4.02 | 3.01 | 3.31 | 2.94 | 2.96 | 2.98 |

Green Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.11 | 1.21 | 0.81 | 1.91 | 1.98 | 1.33 | 1.35 | 1.97 | 1.99 | 1.88 |
| 2 | 0.82 | 0.81 | 0.91 | 2.52 | 1.51 | 1.95 | 0.97 | 1.99 | 1.93 | 1.19 |
| 3 | 1.16 | 1.00 | 0.94 | 2.98 | 2.91 | 2.12 | 1.94 | 2.36 | 1.98 | 1.86 |
| 4 | 0.89 | 1.81 | 1.11 | 3.01 | 1.97 | 1.02 | 1.62 | 1.99 | 3.1 | 2.00 |
| 5 | 0.98 | 1.08 | 1.98 | 2.81 | 2.97 | 1.81 | 1.95 | 1.76 | 3.08 | 1.96 |

Blue Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.95 | 0.89 | 1.93 | 2.61 | 2.78 | 2.79 | 0.995 | 0.997 | 2.09 | 0.19 |
| 2 | 0.89 | 1.91 | 1.91 | 2.52 | 1.51 | 1.95 | 2.97 | 1.99 | 1.93 | 1.19 |
| 3 | 1.21 | 2.02 | 1.99 | 1.18 | 1.81 | 2.521 | 1.14 | 1.76 | 0.99 | 0.96 |
| 4 | 1.22 | 2.91 | 1.11 | 3.01 | 1.97 | 3.02 | 1.73 | 1.99 | 3.1 | 1.01 |
| 5 | 0.76 | 1.21 | 1.54 | 1.91 | 1.87 | 1.11 | 1.125 | 2.56 | 219 | 0.97 |

## Table (6) min distance using Correlation feature with AQ4 logical operator

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.19 | 0.22 | 0.71 | 0.28 | 0.30 | 0.20 | 0.25 | 0.61 | 0.79 | 0.35 |
| 2 | 0.21 | 0.61 | 0.20 | 0.29 | 0.11 | 0.24 | 0.37 | 0.28 | 0.29 | 0.97 |
| 3 | 0.22 | 0.22 | 0.75 | 0.82 | 0.21 | 0.23 | 0.31 | 0.86 | 0.77 | 0.21 |
| 4 | 0.18 | 0.43 | 0.53 | 0.30 | 0.01 | 0.22 | 0.21 | 0.38 | 1.80 | 0.51 |
| 5 | 0.32 | 0.25 | 0.24 | 1.21 | 0.05 | 0.11 | 0.22 | 0.69 | 0.41 | 0.73 |

Red Band

Green Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.47 | 0.44 | 0.27 | 0.27 | 0.34 | 0.46 | 0.81 | 0.71 | 0.23 | 0.19 |
| 2 | 0.21 | 0.12 | 0.43 | 0.67 | 0.21 | 0.17 | 0.44 | 0.76 | 0.31 | 0.72 |
| 3 | 0.41 | 0.28 | 0.25 | 0.11 | 0.72 | 0.96 | 0.15 | 0.94 | 0.55 | 0.12 |
| 4 | 0.67 | 0.31 | 0.53 | 0.51 | 0.57 | 0.14 | 0.22 | 0.23 | 0.13 | 0.32 |
| 5 | 0.23 | 0.32 | 0.23 | 0.61 | 0.14 | 0.32 | 0.21 | 0.70 | 0.32 | 0.88 |

Blue Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.81 | 0.48 | 0.13 | 0.32 | 0.28 | 1.79 | 0.95 | 0.97 | 0.29 | 0.19 |
| 2 | 0.03 | 1.01 | 0.21 | 0.52 | 0.42 | 0.34 | 0.27 | 0.28 | 0.13 | 0.79 |
| 3 | 0.91 | 2.13 | 0.33 | 0.42 | 0.72 | 0.11 | 0.64 | 0.76 | 0.35 | 0.36 |
| 4 | 0.42 | 2.01 | 0.21 | 0.13 | 0.81 | 0.26 | 0.33 | 0.80 | 0.03 | 0.21 |
| 5 | 0.43 | 1.01 | 0.28 | 0.41 | 0.90 | 0.81 | 0.32 | 0.26 | 0.91 | 0.77 |

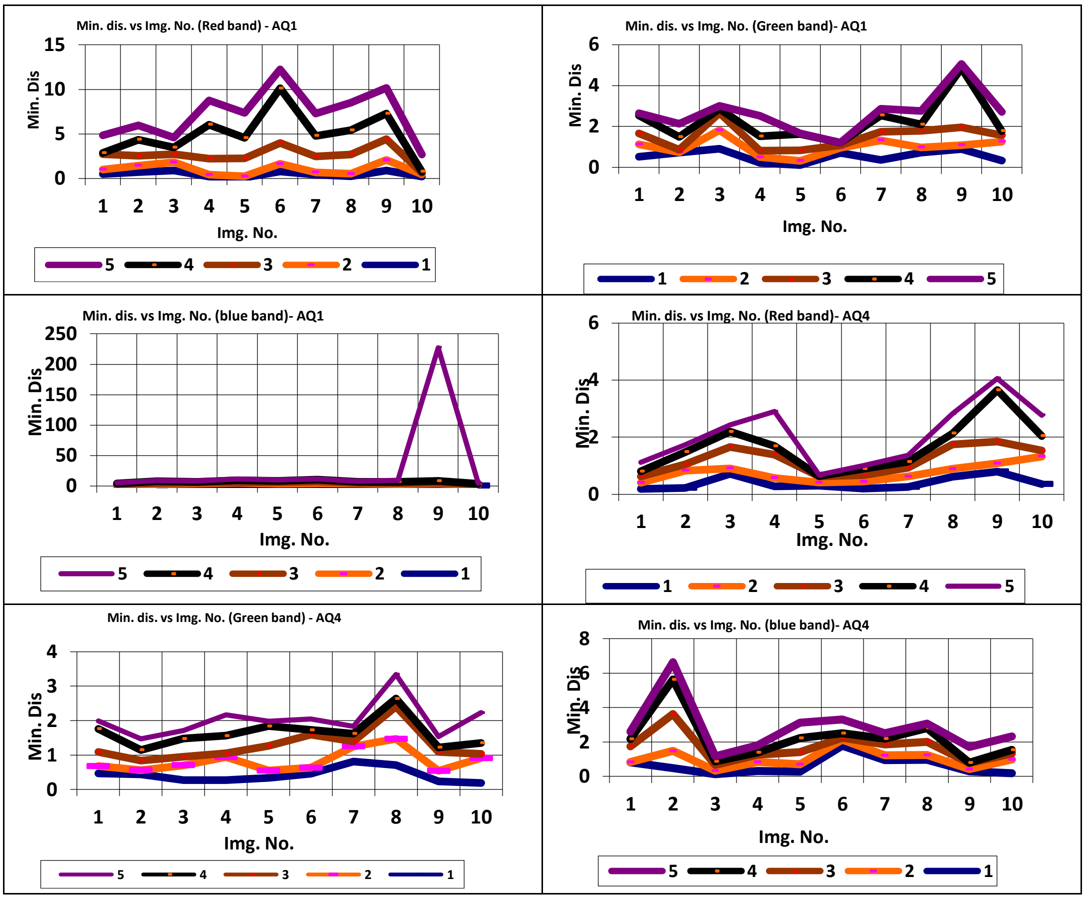


**Fig (4) represented the Correlation with the AQ1 and AQ4 logical operators.**

## Table (7) min distance using Correlation feature with BB1 logical operator

Red Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.27 | 0.48 | 0.13 | 0.32 | 0.28 | 1.79 | 0.95 | 0.97 | 0.19 | 0.19 |
| 2 | 0.67 | 1.01 | 0.21 | 0.52 | 0.42 | 0.34 | 0.27 | 0.28 | 0.72 | 0.79 |
| 3 | 0.11 | 2.13 | 0.33 | 0.42 | 0.72 | 0.11 | 0.64 | 0.76 | 0.12 | 0.36 |
| 4 | 0.51 | 2.01 | 0.21 | 0.13 | 0.81 | 0.26 | 0.33 | 0.80 | 0.32 | 0.21 |
| 5 | 0.61 | 1.01 | 0.28 | 0.41 | 0.90 | 0.81 | 0.32 | 0.26 | 0.88 | 0.77 |

Green Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.47 | 1.81 | 0.71 | 1.91 | 0.27 | 0.13 | 1.77 | 0.28 | 0.32 | 1.88 |
| 2 | 0.21 | 1.91 | 0.20 | 2.52 | 0.67 | 0.21 | 1.95 | 0.42 | 0.52 | 1.19 |
| 3 | 0.41 | 2.00 | 0.75 | 2.98 | 0.11 | 0.33 | 3.53 | 0.72 | 0.42 | 1.86 |
| 4 | 0.67 | 2.91 | 0.53 | 3.01 | 0.51 | 0.21 | 3.02 | 0.81 | 0.13 | 2.00 |
| 5 | 0.23 | 2.08 | 0.24 | 2.81 | 0.61 | 0.28 | 2.91 | 0.90 | 0.41 | 1.96 |

Blue Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.98 | 0.47 | 0.81 | 1.91 | 1.98 | 1.77 | 1.35 | 1.97 | 1.99 | 1.88 |
| 2 | 1.51 | 0.21 | 1.91 | 2.52 | 1.51 | 1.95 | 2.97 | 1.99 | 1.93 | 1.19 |
| 3 | 2.91 | 0.41 | 0.94 | 2.98 | 2.91 | 3.53 | 2.94 | 2.36 | 1.98 | 1.86 |
| 4 | 1.97 | 0.67 | 1.11 | 3.01 | 1.97 | 3.02 | 1.73 | 1.99 | 3.1 | 2.00 |
| 5 | 2.97 | 0.23 | 1.98 | 2.81 | 2.97 | 2.91 | 2.95 | 1.76 | 3.08 | 1.96 |

## Table (8) min distance using Correlation feature with BB2 logical operator

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.19 | 0.52 | 0.13 | 0.20 | 0.25 | 0.20 | 0.15 | 0.21 | 0.19 | 0.23 |
| 2 | 0.21 | 0.17 | 0.12 | 0.24 | 0.37 | 0.26 | 0.17 | 0.20 | 0.19 | 0.32 |
| 3 | 0.22 | 0.32 | 0.27 | 0.23 | 0.31 | 0.25 | 0.17 | 0.31 | 0.77 | 0.31 |
| 4 | 0.18 | 0.52 | 0.31 | 0.22 | 0.21 | 0.21 | 0.31 | 0.31 | 0.29 | 0.31 |
| 5 | 0.32 | 0.15 | 0.12 | 0.11 | 0.22 | 0.21 | 0.32 | 0.29 | 0.27 | 0.63 |

Green Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.67 | 0.64 | 0.18 | 0.77 | 0.43 | 0.56 | 0.31 | 0.71 | 0.93 | 0.89 |
| 2 | 0.12 | 0.32 | 0.63 | 0.87 | 0.24 | 0.87 | 0.54 | 0.76 | 0.21 | 0.72 |
| 3 | 0.51 | 0.68 | 0.35 | 0.71 | 0.82 | 0.66 | 0.45 | 0.34 | 0.45 | 0.86 |
| 4 | 0.87 | 0.32 | 0.43 | 0.21 | 0.87 | 0.34 | 0.12 | 0.23 | 0.73 | 0.12 |
| 5 | 0.33 | 0.12 | 0.73 | 0.76 | 0.84 | 0.32 | 0.21 | 0.90 | 0.52 | 0.78 |

Blue Band

| sample | Img1 | Img2 | Img3 | Img4 | Img5 | Img6 | Img7 | Img8 | Img9 | Img10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.31 | 0.41 | 0.93 | 0.62 | 0.78 | 2.79 | 0.995 | 0.897 | 0.19 | 0.19 |
| 2 | 0.33 | 1.91 | 0.91 | 0.22 | 0.52 | 0.74 | 0.97 | 0.98 | 0.93 | 0.19 |
| 3 | 0.21 | 2.02 | 0.93 | 0.32 | 0.82 | 0.21 | 0.24 | 0.76 | 0.95 | 0.96 |
| 4 | 0.22 | 2.91 | 0.12 | 0.23 | 0.91 | 0.76 | 0.73 | 0.90 | 0.43 | 0.31 |
| 5 | 0.7 | 1.21 | 0.51 | 0.91 | 1.00 | 0.95 | 0.74 | 0.56 | 0.291 | 0.97 |

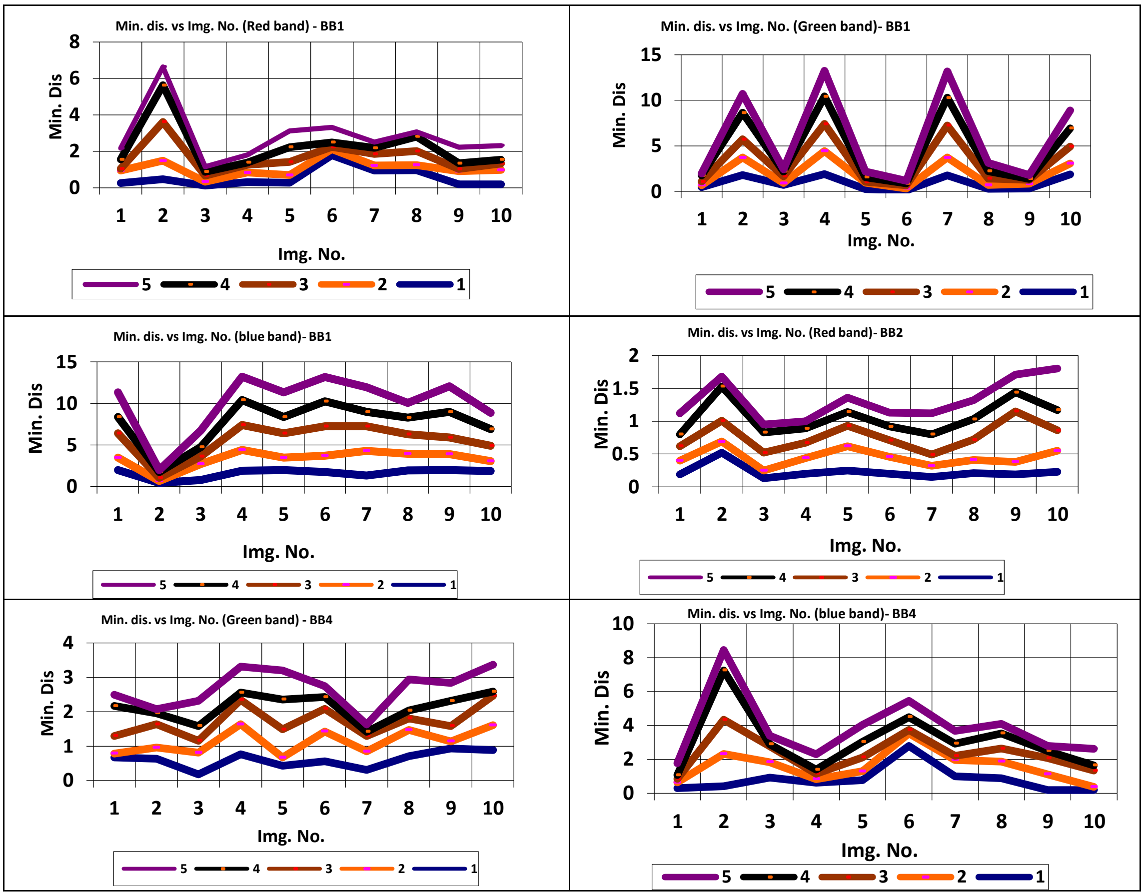


**Fig (5) represented the Correlation with the BB1 and BB2 logical operators.**

## Conclusion:

The calculation of the (J) parameter helps to reduce the feature to (4) and logical operators to (10) when the (J) is small means that good feature and best operators otherwise the feature and operator fails i-e the operators and the feature are bad . After this, to get a good feature analysis the minimum distance is calculated. The best minimum distance reduced the features to (2) and the operators to (4). This gives indication that the best features are the correlation and angular second moment because the correlation gives indication about information distribution of the pixels in the image and the angular second moment gives indication about the measure of homogeneity of the image and the best operators are (AQ1, AQ4, BB1,BB2). This can be shown from the figures(2,3,4 and 5). These figures shows clearly the sketch of the minimum distance between each sample and image for each band. Using three bands with the features calculated from the gray level dependence matrix and the logical operators gives more accurately result.

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# التحليل النسيجي باستخدام Spatial Gray Level Dependence Matrix و نسيج العوامل المنطقية لصور Brodatz

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**الخلاصه:**

يعد تقيم خصائص نسيج الصوره مهما في كثير من معالجات الصور الرقميه. يشكل التحليل النسيجي الاساس لتميز وتصنيف الصور الرقميه في مختلف المجالات. هناك مجموعه من اساليب استخراج المعلومات من الصوره وتحليل نسيجها لغرض فهم خصائص الصوره. في هذا البحث تم اعتماد خوارزميه جديده لتصنيف النسيج تعتمد على اساس نسيج العوامل المنطقيه وعلى واحده من الطرق الاحصائيه لتصنيف الصور الرقميهspatial gray level dependence matrix . لقد استخدمت عشر صور رقميه ماخوذه من Brodatz album واخذت من كل صوره خمس عينات بعد ذلك تم لف 25 عامل من العوامل المنطقيه مع الصور الرقميه و7 من خصائص Spatial gray level dependence matrix تم حسابها وبعد حساب معامل (J) قلت الخصائص الى 3 والعوامل المنطقيه الى 10 ولكن هذا لايكفي لتحليل النسيج فقد تم حساب اقل مسافه بين كل الصور والخمس عينات الخاصه بها اخذين بنظر الاعتبار العوامل والخصائص الماخوذه من **Spatial Gray Level Dependence Matrix** وبعد حساب المسافه قلت الخصائص الى (2) والعوامل المنطقية الى (4) لذالك فان خاصيةcorrelation angular second moment, و (4)من العوامل المنطقيه هي افضل خصائص و عوامل منطقيه يمكن ان نستخدمها لتحليل النسيج.