i.

The resampling method used in this paper is as follows. For

each odd line, find the midpoint between two adjacent pixels

by simple linear interpolation (i.e., mid = (left + right) / 2)

[16]. Discard the left and right, keeping only the mid values.

This gives us a hexagonal mapping from a regular square or

rectangular grid. The procedure is as follows:

*p new* ( *x* ,2 *y* ) = *p old* (*x* ,2 *y*)

*pnew*(*x*,2*y*+1) = (*pold* (*x*,2*y*+1)+ *pold*(*x*+1,2*y*+1))/ 2

During the acquisition of the images from rectangular

lattice to the hexagonal lattice, it was observed that there is a

considerable loss in image quality [Fig.2(a)].So, selection of

suitable interpolation technique is needed before processing

the image. Image reconstruction through interpolation is

routine task in image processing during all transformation that

is made on an image. Such transformations include scaling,

rotation, registration, and edge detection.

ii

Experiments revealed that a Gabor filter takes the

form of a Gaussian modulated complex sinusoid in the spatial

domain. The standard definition proposed by B. S. Manjunath

and W. Y. Ma [34] is used (Equation 3).A two dimensional

Gabor function *g(x, y)* and its Fourier transform *G(u, v)* can be

written as:

eqn.

In the frequency domain,

Eqn.

While σ*x* and σ*y* are the standard deviations of the elliptical

Gaussian along *x* and *y* axes. The DC values of 2D Gabor

filters were removed in order to eliminate high response to

absolute intensity values. Filter parameters were obtained

using the following Formulas:

eqn

Where *S* is the total number of stages and *m* = 0,1, \_\_\_*S-*1.

The DC values of 2D Gabor filters were removed in order to

eliminate high response to absolute intensity values.

iii.

*B.Gabor filter bank for hexagonal sampled Image*

Next the filter bank was carried out with three orientations 00

, 600 and 1200. The filter bank was applied to the hexagonal

sampled images e.g chestxray.tif - Figure 2(b) which is of

poor quality obtained for the input image shown in Figure

2(a).Half pixel shift method for the acquisition of hexagonal

lattice from rectangular lattice is used as reported in our

earlier paper [36-37].

Fig. 4 (a) Gabor kernel and (b) Gabor filter bank with σg =5.82 ;F =

0.1786

Fig. 5 (a) Gabor kernel and (b) Gabor filter bank with σg =

2.91 ;F = 0.3536

The image resulting from the filtering process is shown in

Figure 6(b) with clarity in the image. The results show that

that the proposed methodology works effectively with any

complete directional decomposition.

-------------------------------------------------------------------------------------------------------------

P vidya.

Gabor is the only filter which is having the property of

directionality. Due to the 3 different axis of symmetry of

hexagonal lattice, more importance is given for orientation

selectivity. So this paper used the orientation selectivity filter

like Gabor filter for the purpose of edge detection on hexagonal

domain.Gabor expansion is a time frequency analysis method

which combines both the time/space and frequency information.

Gabor expansion can be implemented as a multi-channel filter.

) exp( ( cos sin )

2

exp( ( )

2

( , ; , , ) 1 2

2 2

2 θ ω θ

σ σ

ω θ σ *x y g x y x y i w* +

− +

Π

= ) (1)

The Gabor filter can be mathematically represented as (1)

where Gabor parameters like ω, θ and σ represents radial

frequency, orientation and spatial extension respectively. Due

to the three axis of symmetry of hexagonal grid we should

choose three different orientations along 00, 600 and 1200.

Iv

Fourier Descriptor (FD) and Moment Invariants are used for shape

analysis since they are perfect shape descriptor and do not produce redundant values. Since the

colored image has several kinds of objects, Fourier descriptor may be the best possible descriptor

for calculating the boundaries of the objects present in the images. The proposed shape descriptor

is derived by applying 2-D Fourier transform on an image. The acquired shape descriptor is

application independent and robust. Their main advantages are that they are invariant to

translation, rotation and scaling of the observed object. Thus shape description become

independent of the relative position and size of the object in the input image

**Color Analysis**

We use HSV color model for extracting color feature such as hue, saturation and value which is a

type of color space. In HSV, hue represents color, Saturation indicates the range of grey in the

color space and Value is the brightness of the color and varies with color saturation. The

advantage of using HSV color space is that it selects various different colors needed from a

particular image. In general it gives the color according to human perception [15].

**Distance Calculation**

The efficiency and accuracy of the image retrieval is significantly affected by the ability of the

distance calculation techniques. Let be the feature vector of the

candidate image and be the feature vector of the incomplete query

image. Euclidean distance between the candidate image feature vector and the query image

feature vector is given by [17]. The result of the distance calculation is used for retrieving images

similar to incomplete query image.

Filtering techniques

1. Mean filter

is the simplest low pass linear filter. It is implemented by replacing each pixel

value with the average value of its neighbourhood. Mean filter can be considered as a

convolution filter. The smoothing effect depends on the kernel size. As the kernel size

increases, the smoothing effect increases too. Usually a 3×3 (or larger) kernel filter is used.

An example of a single 3×3 kernel is shown in the Fig. 5.



**3.4.4.2 Median filter**

Median filter is a non linear filter. Median filtering is done by replacing the central pixel

with the median of all the pixels value in the current neighbourhood.

A median filter is a useful tool for impulse noise reduction (Toprak & Göller, 2006). The

impulse noise (it is also known as salt and paper noise) appears as black or (/and) white

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pixels randomly distributed all over the image. In other words, impulse noise corresponds

to pixels with extremely high or low values. Median filters have the advantage to preserve

edges without blurring the image in contrast to smoothing filters.

****

**3.4.4.3 Gaussian filter**

Gaussian filter is a linear low pass filter. A Gaussian filter mask has the form of a bellshaped

curve with a high point in the centre and symmetrically tapering sections to either

side (Fig.7). Application of the Gaussian filter produces, for each pixel in the image, a

weighted average such that central pixel contributes more significantly to the result than

pixels at the mask edges (O’Gorman et al., 2008). The weights are computed according to the

Gaussian function (Eq.1):

*f x e*

μ σ

σ π

=

**Algorithm:** For calculating GLCM measures for each

pixel:

1. Read the input image.

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2. Convert the data type to double and Zero pad the

image

3. Extract a 3×3 window image from the input image

and compute the co-occurrence texture measure

4. Estimate the texture parameters for the obtained

texture image

5. Repeat the step3 and step4 by moving the window

till the end of the image

6. Display various texture parameters by normalizing

them

**K-means clustering:** K-means clustering is a simple

algorithm to clustering the texture regions of an image.

For K clusters {C1, C2… CK} each with nk patterns aim

to find cluster centers mk to minimize the cost function

2

K E where Eq. 7 and 8:

k

K =

k xÎC

1

M X

n

Σ (7)

K

k

k

2 2

k

k =1 xÎC

E =Σ Σ|| X -m || (8)

The initial cluster midpoints are selected randomly

and the algorithm is applied repeatedly until a fixed

state level is arrived.

**Algorithm:** For K-means clustering:

1. Initialize cluster centers randomly in texture image

2. For all the pixels in the image do the following

a) Compute the Euclidean distance of the feature

vector from the cluster for every other cluster.

b) Assign the pixel to that cluster whose center

yields the minimum distance from the feature

vector

3. Update the cluster centers by computing the mean

of the feature vectors of the pixels belonging to

that cluster

4. Between two consecutive updates, if the changes in

the cluster centers are less than a specified value,

then stop

Else go to step 2

**Similarity comparison:** For similarity comparison,

we have used Euclidean distance, d is using the

following Eq. 9:

N

2

Q DB

i=1

d = Σ(F [i] - F [i]) (9)

Where:

FQ[i] = The ith query image feature

FDB [i] = The corresponding feature in the feature

vector database

Here N refers to the number of images in the

database (Nandagopalan *et al*., 2008).