REPORT ON-

DSIP MINI-PROJECT-

TEXTURE FEATURE EXTRACTION FROM A DIGITAL IMAGE

BY-

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Problem Statement-

Texture Feature extraction from a digital image.

Group members-

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Abstract-

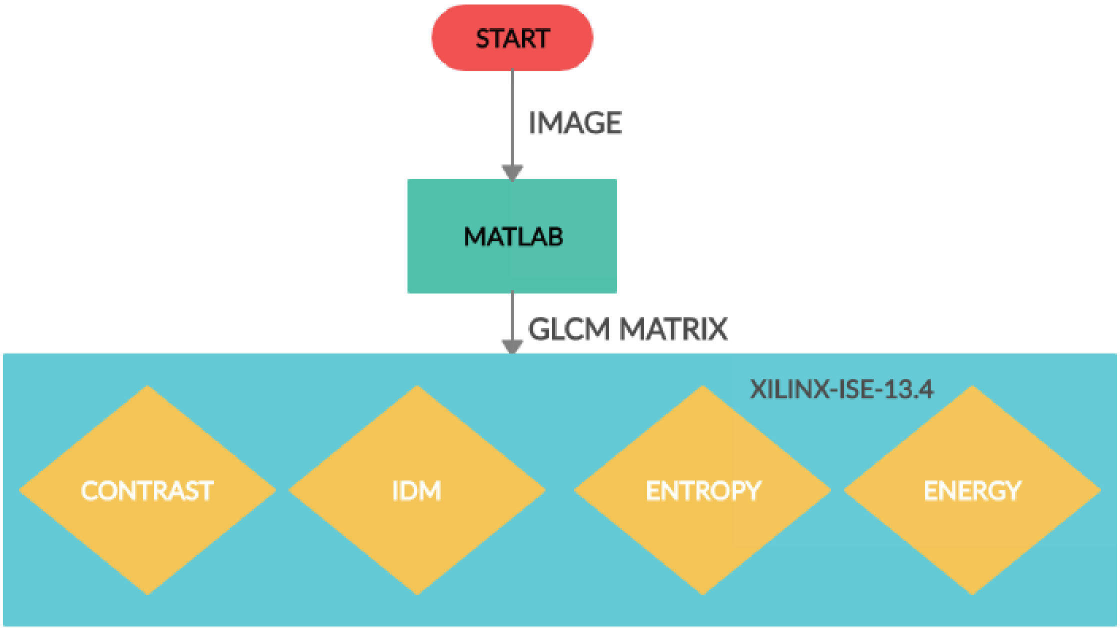
Feature Extraction is a method of capturing visual content of images for indexing & retrieval. Primitive or low level image features can be either general features, such as extraction of colour, texture and shape or domain specific features. This report presents an application of grey level co-occurrence matrix (GLCM) to extract second order statistical texture features for motion estimation of images. The Four features namely, Energy, Contrast, Inverse Difference Moment, and Entropy are computed using Xilinx FPGA. The results show that

these texture features have high discrimination accuracy, requires less computation time and hence efficiently used for real time Pattern recognition applications.

Introduction-

Image analysis involves investigation of the image data for a specific application. Normally, the raw data of a set of images is analysed to gain insight into what is happening with the images and how they can be used to extract desired information. In image processing and pattern recognition, feature extraction is an important step, which is a special form of dimensionality reduction. When the input data is too large to be processed and suspected to be redundant then the data is transformed into a reduced set of feature representations. The process of transforming the input data into a set of features is called feature extraction. Features often contain information relative to colour, shape, texture or context.

Block diagram-



Methodology-

EXTRACTION OF GLCM-

In statistical texture analysis, texture features are computed from the statistical distribution of observed combinations of intensities at specified positions relative to each other in the image. According to the number of intensity points (pixels) in each combination, statistics are classified into first-order, second order and higher-order statistics. The Gray Level Coocurrence Matrix (GLCM) method is a way of extracting second order statistical texture features. The approach has been used in a number of applications, Third and higher order textures consider the relationships among three or more pixels. These are theoretically possible but not commonly implemented due to calculation time and interpretation difficulty. A GLCM is a matrix where the number of rows and columns is equal to the number of gray levels, G, in the image. The matrix element P (i, j | Δx, Δy) is the relative frequency with which two pixels, separated by a pixel distance (Δx, Δy), occur within a given neighborhood, one with intensity 'i' and the other with intensity 'j'. The matrix element P (i, j | d, ɵ) contains the second order statistical probability values for changes between gray levels 'i' and 'j' at a particular displacement distance d and at a particular angle (ɵ). Using a large number of intensity levels G implies storing a lot of temporary data, i.e. a G × G matrix for each combination of (Δx, Δy) or (d, ɵ). Due to their large dimensionality, the GLCM's are very sensitive to the size of the texture samples on which they are estimated. Thus, the number of gray levels is often reduced. GLCM matrix formulation can be explained with the example illustrated in fig 2.1 for four different gray levels. Here one pixel offset is used (a reference pixel and its immediate neighbour). If the window is large enough, using a larger offset is possible. The top left cell will be filled with the number of times the combination 0,0 occurs, i.e. how many time within the image area a pixel with grey level 0 (neighbour pixel) falls to the right of another pixel with grey level 0(reference pixel).

neighbour pixel value ---> ref pixel value:	0	1	2	3
0	0,0	0,1	0,2	0,3
1	1,0	1,1	1,2	1,3
2	2,0	2,1	2,2	2,3
3	3,0	3,1	3,2	3,3

The MATLAB code used for the GLCM is q1 = imread ('Jerry.jpg'); w1 = rgb2gray (q1); e1 = imresize (w1, [128 128]); r1 = graycomatrix (e1); disp (r1); t1 = imhist (e1); figure, imshow (e1), title ('transformed gray Jerry .jpg in gray'); the output will be an 8*8matrix which is a GLCM of input image.

<u>EXTRACTION OF TEXTURE FEATURES OF IMAGE-</u>

Gray Level Co-Occurrence Matrix (GLCM) has proved to be a popular statistical method of extracting textural feature from images. According to co-occurrence matrix, Haralick defines fourteen textural features measured from the probability matrix to extract the characteristics of texture statistics of remote sensing images.

We have used four important features- Angular Second Moment (energy), Contrast, Entropy, and the Inverse Difference Moment (IDM) which are selected for implementation using Xilinx ISE 13.4

- Energy-

  Energy (E) can be defined as the measure of the extent of pixel pair repetitions. It measures the uniformity of an image. When pixels are very similar, the energy value will be large.

  It is defined in Equation as: temp = GLCM .^ 2; energy = sum(temp(:));

- Entropy-

  This concept comes from thermodynamics. Entropy (Ent) is the measure of randomness that is used to characterize the texture of the input image. Its value will be maximum when all the elements of the co-occurrence matrix are the same.

It is also defined as in Equation as: temp = GLCM .* log(GLCM); temp(isnan(temp)) = 0; entropy = -1 * sum(temp(:));

- Contrast-

The contrast (Con) is defined in Equation, is a measure of intensity of a pixel and its neighbour over the image. In the visual perception 105 of the real world, contrast is determined by the difference in the colour and brightness of the object and other objects within the same field of view.

Contrast is calculated by: contrast = contrast + ((i-j)^2 * GLCM(i, j)); where I and J are rows and columns of GLCM matrix.

- Inverse Difference Moment-

Inverse Difference Moment (IDM) is a measure of image texture as defined in Equation. IDM is usually called homogeneity that measures the local homogeneity of an image. IDM feature obtains the measures of the closeness of the distribution of the GLCM elements to the GLCM diagonal. IDM has a range of values so as to determine whether the image is textured or non-textured.

IDM is calculated by: idm = idm + (GLCM(i, j) / (1 + (i-j)^2)); where I and J are rows and columns of GLCM Matrix.

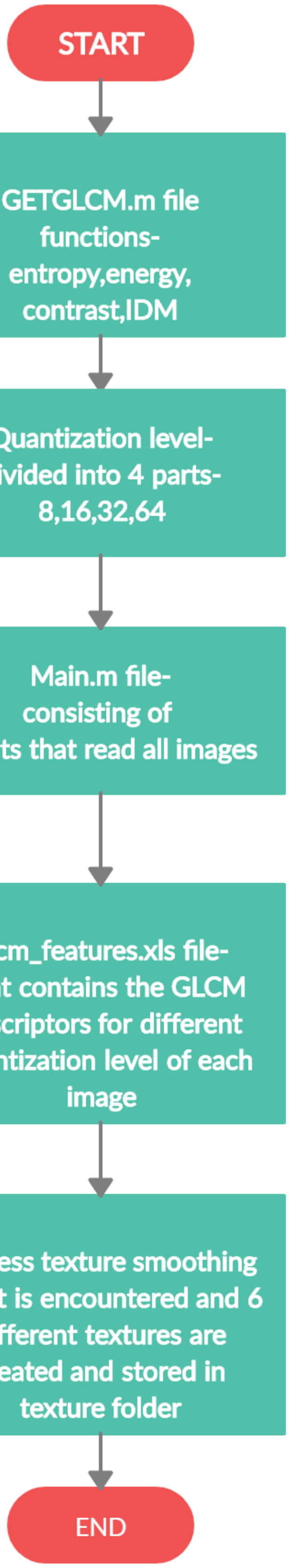
Texture features extracted using GLCM-

Energy	Entropy	Contrast	IDM
0.2398	6.8042	0.124	6.15E+04
0.1949	7.0086	0.1904	6.01E+04
0.3168	6.4868	0.2488	5.99E+04
0.1524	6.7707	0.2025	5.95E+04
0.7568	5.5702	0.12	6.28E+04
0.1655	7.3033	0.1999	5.93E+04
0.313	6.6852	0.1464	6.12E+04
0.2236	6.9529	0.1739	6.10E+04
0.5483	5.8905	0.1019	6.26E+04
0.5583	5.9409	0.1524	6.26E+04
0.5143	6.1439	0.0794	6.31E+04
0.2486	6.6115	0.1654	6.06E+04
0.1608	6.88	0.1993	6.05E+04
0.4855	5.9474	0.0953	6.28E+04
0.1613	6.9496	0.1639	6.07E+04
0.2853	6.4627	0.2106	6.01E+04
0.1477	7.0368	0.3293	5.73E+04
0.316	5.9372	0.1803	6.03E+04
0.3046	6.4706	0.1998	6.03E+04
0.2796	6.4406	0.2019	6.02E+04
0.573	6.0185	0.1416	6.21E+04
0.1729	7.2134	0.1497	6.05E+04
0.3145	6.804	0.1592	6.09E+04
0.7637	5.3457	0.0753	6.35E+04
0.6113	5.8042	0.138	6.19E+04
0.7586	5.3523	0.0594	6.37E+04
0.3124	6.2919	0.1397	6.15E+04
0.5817	6.0175	0.1585	6.14E+04
0.1226	7.1201	0.2642	5.73E+04
0.1993	7.2553	0.2249	5.89E+04
0.7293	5.5209	0.1787	6.16E+04
0.5257	6.4206	0.091	6.30E+04
0.3006	6.4985	0.1749	6.10E+04
0.1576	6.8883	0.1738	6.04E+04
0.1929	7.1205	0.2127	5.86E+04
0.1727	7.1763	0.2284	5.80E+04
0.8759	5.0943	0.0371	6.46E+04
0.285	6.7064	0.1587	6.09E+04
0.1382	7.4154	0.19	5.94E+04
0.3316	6.7746	0.1325	6.16E+04

Pseudo code-

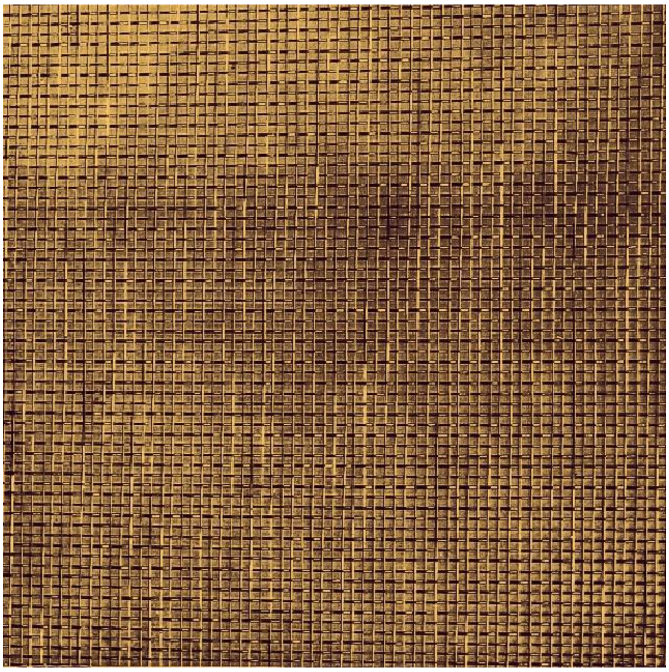
1. The **getGLCM.m** is the file which consist of functions that return the energy, entropy, contrast and inverse difference moment after calculating the GLCM in vertical as well as horizontal direction for the given quantization level.
2. The quantization level of the above defined fucntions is divided into 4 parts as (8,16,32,64) and inbuilt matlab GLCM method is pass to gain textures of an input image
3. The **main.m** file consist of script that reads all the images in the image base and calculates the GLCM descriptor of these images.
4. After the calculation of these features, the Euclidean distance of each of these images is calculated from the input image and stored in an xls file.
5. The **(glcm_features.xls**) file that contains the GLCM descriptors for different quantization level of each image in the image base along with the euclidean distance of the image from the query image
6. Based on these values the texture smoothing effect is encountered and 6 different textures are created and stored in texture folder
7. When the main file is compiled and run these 6 images based on the functions specified in displayed on the output screen.

Flow chart-


START
GETGLCM.m file functions- entropy,energy, contrast,IDM
Quantization level- divided into 4 parts- 8,16,32,64
Main.m file- consisting of scripts that read all images
glcm_features.xls file- that contains the GLCM descriptors for different quantization level of each image
Process texture smoothing effect is encountered and 6 different textures are created and stored in texture folder
END

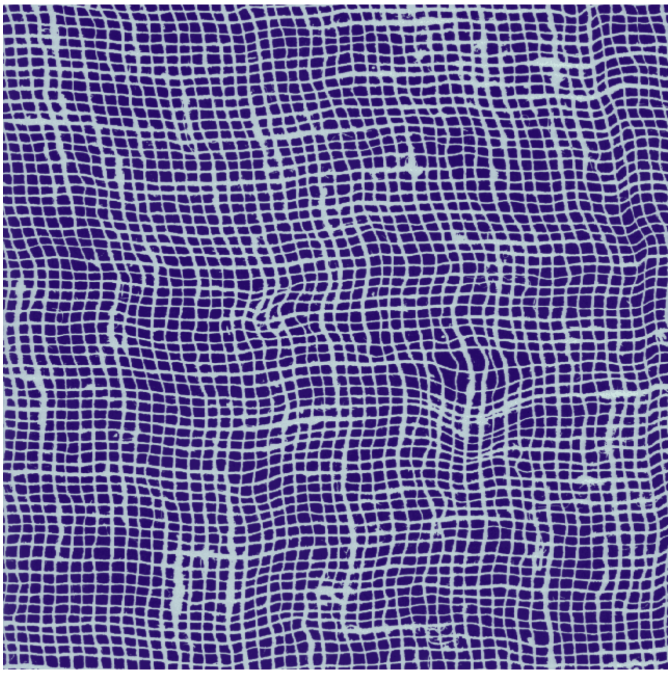
Results-

- The GLCM functions produced lot of textures. Approximately 100.



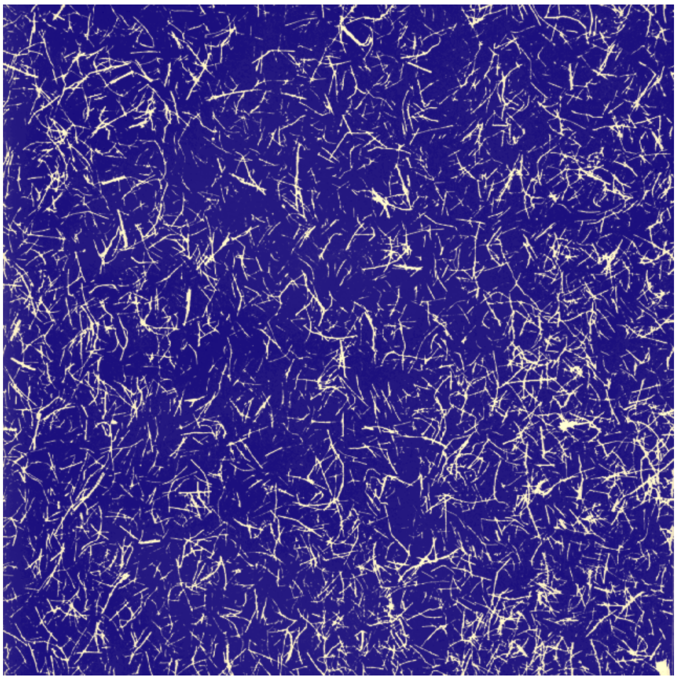
INPUT IMAGE

- Top 6 extracted results are as follows-

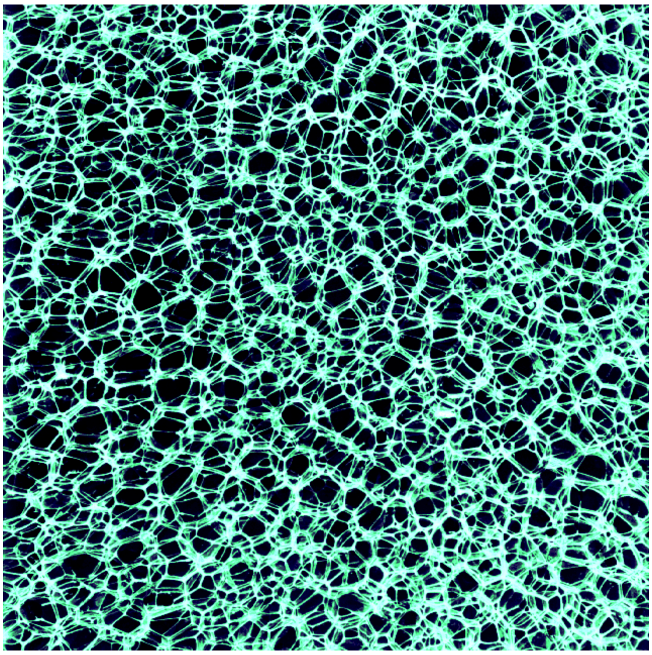


TEXTURE-1

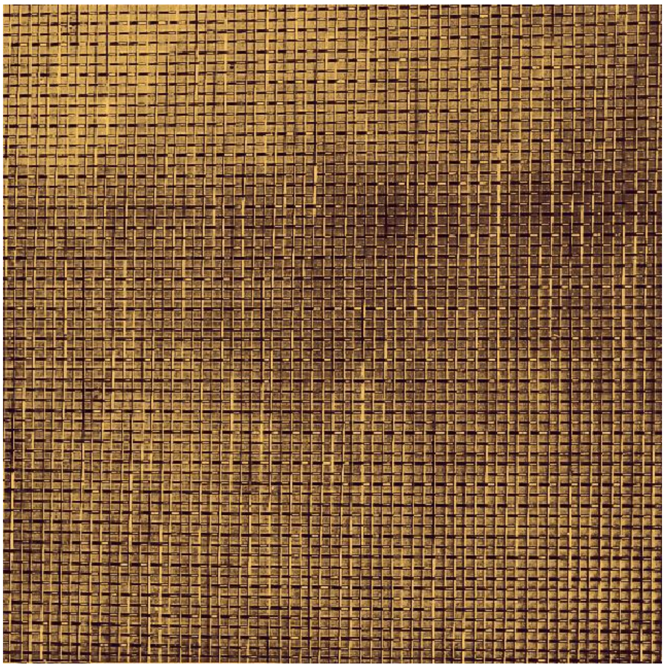
TEXTURE-2



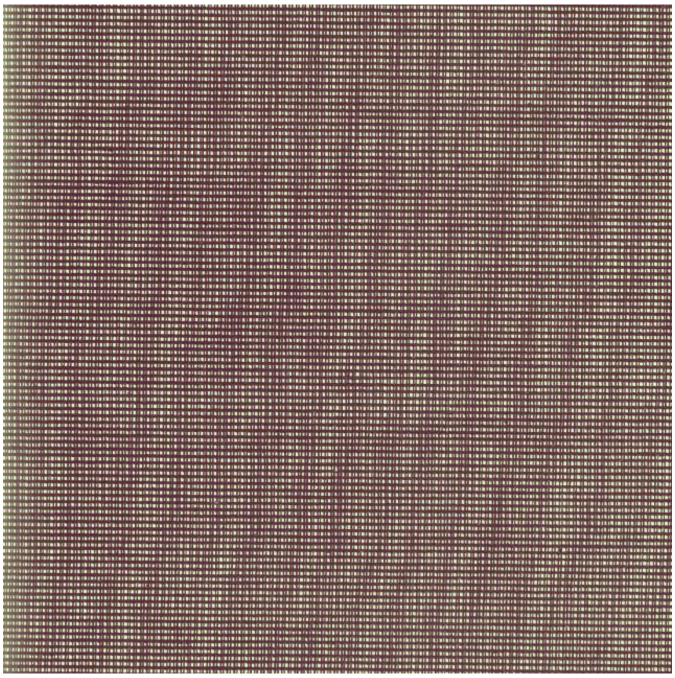
TEXTURE-3



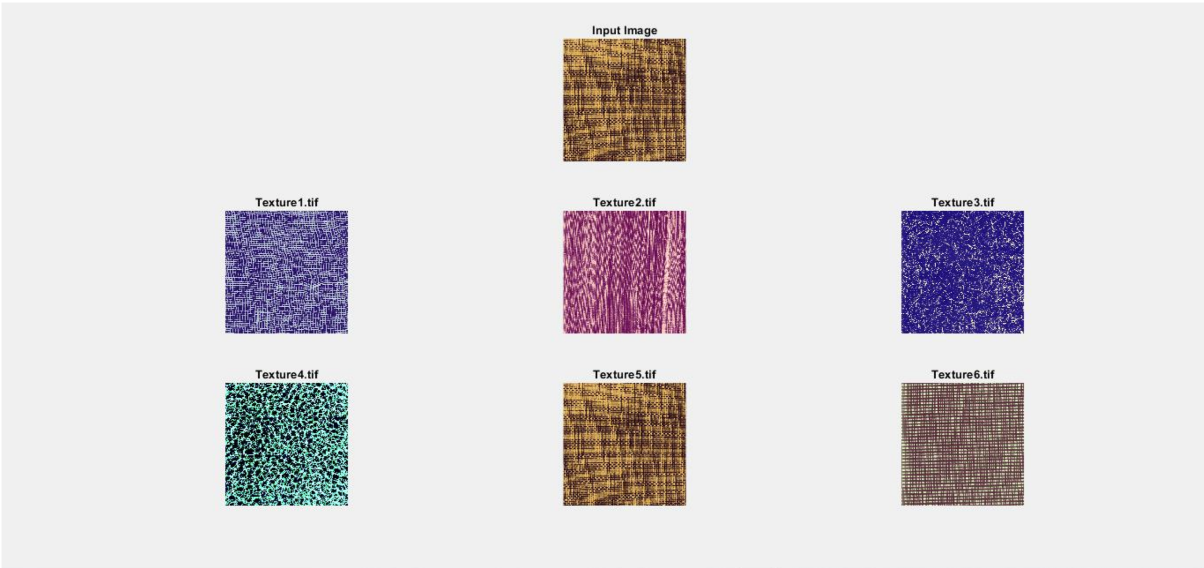
TEXTURE-4



TEXTURE-5



TEXTURE-6


Input Image
Texture1.tif
Texture2.tif
Texture3.tif
Texture4.tif
Texture5.tif
Texture6.tif

Analysis-

- The Gray Level Co-ocurrence Matrix (GLCM) method is used for extracting Textures parameters i.e Contrast, Energy, Entropy and Inverse Difference Moment (IDM).
- By extracting the features of an image by GLCM approach the image compression time can be greatly reduced in the process of converting RGB to Gray Level Image when compared to other DWT techniques.

Applications-

Texture analysis methods have been utilized in a variety of application domains such as automated inspection, medical image processing, document processing, remote sensing and content-based image retrieval.

Remote Sensing-

Texture analysis has been extensively used to classify remotely sensed images. Land use classification where homogeneous regions with different types of terrains (such as wheat, bodies of water, urban regions, etc.) need to be identified is an important application.

Medical Image Analysis-

Image analysis techniques have played an important role in several medical applications. In general, the applications involve the automatic extraction of features from the image which is then used for a variety of classification tasks, such as distinguishing normal tissue from abnormal tissue. Depending upon the particular classification task, the extracted features capture morphological properties, colour properties, or certain textural properties of the image.

Conclusion-

The Gray Level Co-occurrence Matrix (GLCM) method is used to obtain energy, entropy, contrast, inverse difference moment. These texture features are served as the input to classify the image accurately. By extracting the features of an image by GLCM approach, the image compression time can be greatly reduced in the process of converting RGB to Gray level image when compared to other DWT Techniques, but however DWT is versatile method of compressing video as a whole. Effective use of multiple features of the image and the selection of a suitable classification method are especially significant for improving classification accuracy These features are useful in motion estimation of videos and in real time pattern recognition applications like Military & Medical Applications.

References-

- **https://youtu.be/LQBKIi-Xtbc** ***Title-*** **Texture Analysis**
  Channel- **UC Davis**

- **Image Texture Feature Extraction Using GLCM Approach by -** P. Mohanaiah, P. Sathyanarayana, L. Guru Kumar (International Journal of Scientific and Research Publications, Volume 3, Issue 5, May 2013 1 ISSN 2250-3153)

- **CHAPTER 4 TEXTURE FEATURE EXTRACTION- By** shodhganga.inflibnet (https://shodhganga.inflibnet.ac.in/bitstream/10603/24460/9/09_chapter4.pdf)