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# Classification and Retrieval of Texture Images Using Gabor Filtering and Statistical Features

**Vaishnavi Gadewar**
*International Institute Of Information Technology, Pune*
*gvaishnavi761@gmail.com*

**Apoorva Deshmukh**
*International Institute Of Information Technology, Pune*
*apurvaprajkta@gmail.com*

**Akshay Ekurge**
*International Institute Of Information Technology, Pune*
*ekurge@gmail.com*

**Ashok Shinde**
*International Institute Of Information Technology, Pune*
*ashoks@isquareit.edu.in*

***Abstract:*** ***Content-Based Image Retrieval (CBIR) is a developing trend in Digital Image Processing. CBIR is used to search and retrieve the query image from a wide range of database. Many features and algorithms can be used for efficient image retrieval. The features of CBIR as colours, shapes, textures etc. can be derived from the image itself. This project represents the retrieval of images based on the texture images. The focus of the project is on the images processing aspects and particular using texture features. With the help of Gabor filter features and some statistical feature of texture images, we form a feature vector for extraction of features. For retrieval of images, these features are useful. The most accurate result is obtained using Gabor features applied on Brodatz texture database. For comparing and finding similarity between features of the query image and another image in the database is done by using Euclidean distance, Vector cosine angle distance, and Manhattan distance. To analyze the better performance of retrieval of images these distances we plot the precision and recall graph with a number of retrieved images respectively.***

***Keywords: Texture, Feature Vector, Feature extraction, Distance Matrices, Precision & Recall***

## I.INTRODUCTION

Image retrieval system is a type of automated computer system which can be used for storage and retrieve images. In this system, we can browse, search for particular query image from the large database. This database consists of a large number of digital images for retrieving in which we can also add images and store them. Image search is a specialized data search used to find images

### 1.1 Content Based Image Retrieval

CBIR is one of the most important and effective methods for retrieval of images from a large database of digital Images which is widely studied in both academic industrial area. In CBIR we mainly concentrate on texture, shape and color features. In color feature method images are examined based on colors. Texture measures look for visual patterns in the image. While in shape feature information is captured in terms of the edge image of the grayscale equivalent of every image in the database.

### 1.2 Texture-based Image Retrieval

#### 1.2.1 Texture images

Spectral, Textural & logical elements are 3 crucial example components utilized as a part of the human translation of shading photos. The texture is formed due to variation in the intensity & colour. The texture is present in the form of repeated patterns. Texture mostly depends on scale.

#### 1.2.2 Texture Analysis Methods

Texture analysis can be done in three ways:

1. Statistical methods: statistical methods can be used to model textures. Grey level co-occurrences matrix is one of the parameters. Along with it we can use other parameters like moment, smoothness, skewness etc.

2. Spectral methods: In spectral methods use transforms such as FFT to characterize textures

3. Structural methods: Spatial relationships among primitives are used to model textures.

## II.LITERATURE SURVEY

There are mainly 3 techniques for recovery of images that are image metadata, CBIR, image gathering investigation. Texture can be classified as fine, coarse or smooth, irregular. Based on the size of primitives textures are 2 types' micro & macro textures. Among all other texture transform features, Gabor filter feature gives a good result. The similarity in images can be found by various distance matrices.

## III.PROPOSED METHODOLOGY

For this project, we use Matlab software and BZ database for retrieval & classification of images.

### 3.1 Selection of Database and Creation

For this project, we are using Brodatz Database (BZ Database). This database has storage of 111 digital textural images each of dimension 640 *640 in GIF format. For Database creation, we divided every image into the dimension of 128*128 of sub-images. Therefore total no of images present in our database is 2775(111 *25) each of size 128*128 in BMP format.

### 3.2 Features used for feature extraction

#### 3.2.1 Gabor filter

If the image is rotated by certain angle its response is represented by Gabor filter in filter bank which has been rotated by the same amount as that of the image when the features are concatenated as vectors.

$$G(x,y,\theta,f) = exp\left(\frac{-1}{2}\left(\frac{x'}{sx'}\right)^2 + \left(\frac{y'}{sy''}\right)^2\right)\cos(2\pi \times f \times x')$$

$x' = x \times \cos\theta + y \times \sin\theta$

$y' = y \times \cos\theta - x \times \sin\theta$

Where,

sx and sy: Variances along x and y-axes respectively.

f :The frequency of sinusoidal function.

$\theta$:The orientation of Gabor Filter.

G :The output of the filter.

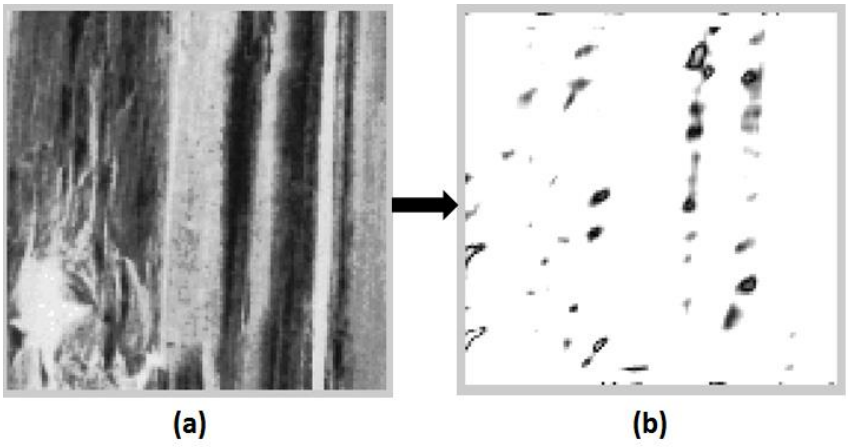



**Fig: Gabor Filtering: (a) Input Image (b) Output Image**

#### 3.2.2 Statistical Features

We are using statistical features for texture analysis and extraction of features. Therefore in our feature vector, we are using three features mainly mean, skewness and variance.

**Mean**

Mean is the average of all pixel values present in the image.
Mean:

$$\bar{X} = \frac{\sum xi}{n}$$

**Variance**

Variance is the measure of the spread between numbers in a data set.
Variance:

$$\sigma^2 = \frac{\sum(X-\mu)^2}{N}$$

**Skewness**

It is a measure of the asymmetry of the probability distribution of real-valued random variable from its mean. For samples of n values, natural methods of moments estimator of the population skewness is

**Skewness:**

$$b1 = \frac{m^3}{s^3} = \frac{\frac{1}{n}\sum_{i=1}^{n}(X_i-\bar{X})^3}{\frac{1}{(n-1)}\sum_{i=1}^{n}(X_i-\bar{X})^{\frac{3}{2}}}$$

### 3.2.3 Calculation and Formation of Feature Vector

We used 5 scale factors, 8 angles in Gabor filter & 3 operations (Mean, Variance & Skewness).Therefore the feature vector formed is of length 5*8*3=120.

### 3.2.4 Distance Metrics for Finding Similarity in Images

To measure the distance for finding similarity between query image & database images, the distance matrices like Manhattan distance, Euclidean distance & Vector cosine angle distance are used. Distance matrices measured difference between two vectors of images having most similar features from a large database.

#### 3.2.4.1 Euclidean Distance

This distance formula is used for finding distance between two vectors or points in hyperplane.7

$$ED(i) = \sqrt{\sum_{i=0}^{n}(FV(i)-FV1)^2}$$

#### 3.2.4.2 Manhattan Distance

Consider if $u = (x_{1,}x_{2,\ldots\ldots,}x_{n,})$ & $v = (y_{1,}y_{2,\ldots\ldots,}y_{n,})$ are two vectors in n dimensional hyper plane, than the Manhattan distance MD (u,v) between two vectors u,v is given by the equation

$$MD(U,V) = \sum_{i=1}^{n}|X_i - Y_i|$$

#### 3.2.4.3 Vector Cosine Angle Distance

It is the measure distance between two points in n-dimensional hyperplane which performs better where Euclidean Distance contains some limitations.

$$V_{cad}(U,V) = \frac{U.V}{||U||.||V||}$$

### 3.2.5 Precision & Recall

**Precision:**

Precision refers to the closeness of two or more measurements to each other. In the field of information retrieval, precision is the fraction of retrieved documents that are relevant to the query.

$$Precision = \frac{Relevant\ Retrieved}{Total\ Relevant\ + Total\ irrelevant}$$

**Recall:**

Recall in information retrieval is the fraction of the documents that are relevant to the query that are successfully retrieved.

$$Recall = \frac{Relevant\ Retrieved}{Total\ Relevant}$$

## IV.IMPLEMENTATION FLOWCHART

First, we calculate the invariance of the descriptor if the images are subjected to rotation & scales changes. For this, we apply gabor filter on images in the database. The Statistical features such as mean, variance & skewness are used for feature extraction that interprets the rotation & scale changes. From a feature vector FV1 of 3 Statistical feature & another feature vector FV of 5 scales, 8 angles & 3 Statistical features of feature vector length 120.For comparison & finding similarity between query image with other images in the database, we used 3 different distances matrices as Euclidean distance, Manhattan distance & Vector cosine angle distance which extract the similar features of images from FV1 & FV vectors. For analysing the better performance of retrieval of images by using distance we plot precision & recall graph with a number of retrieval images respectively. Also, we plot the precision versus recall graphs.

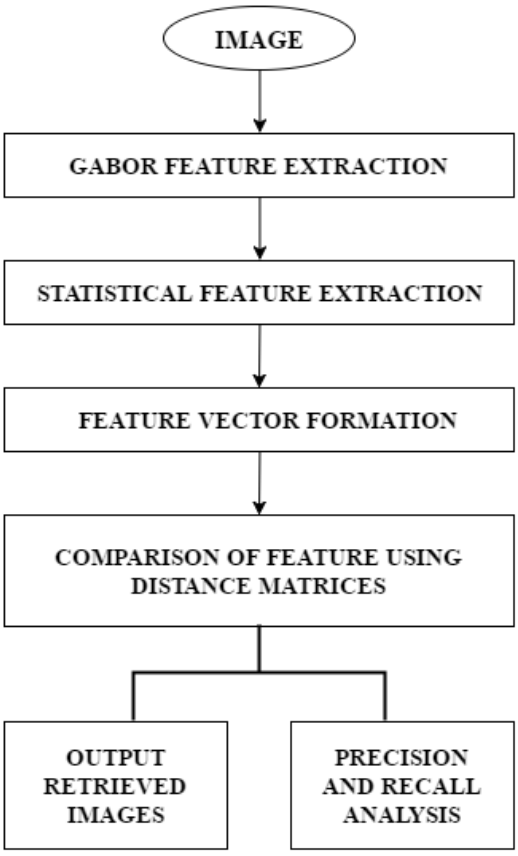



**Fig.: Implementation Flowchart**

## V. RESULT

### 5.1 Results of retrieved images

These are the retrieved results obtained by 3 distance matrices as Euclidean distance, Manhattan distance, Vector cosine angle distance.

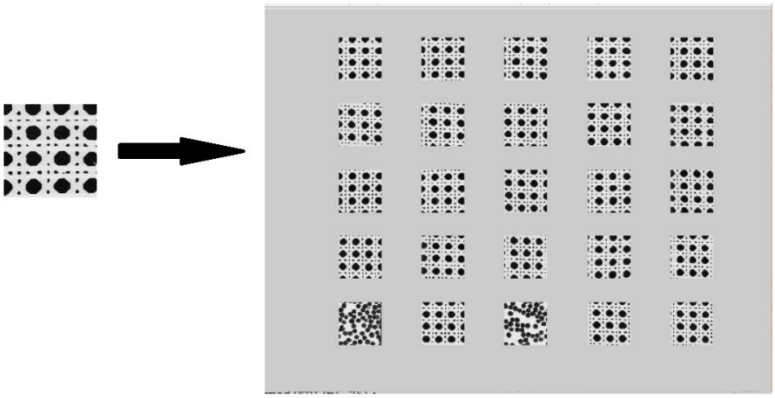


**Fig.: Euclidean Distance result.**

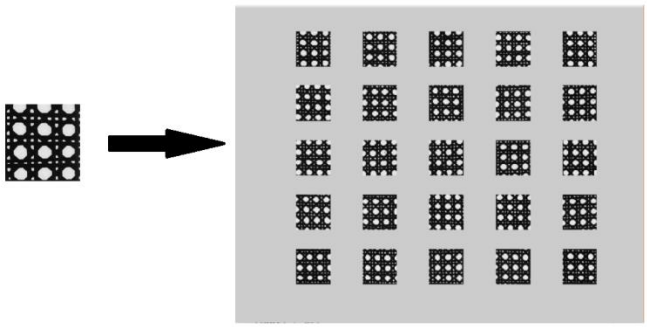


**Fig.: Manhattan Distance result.**

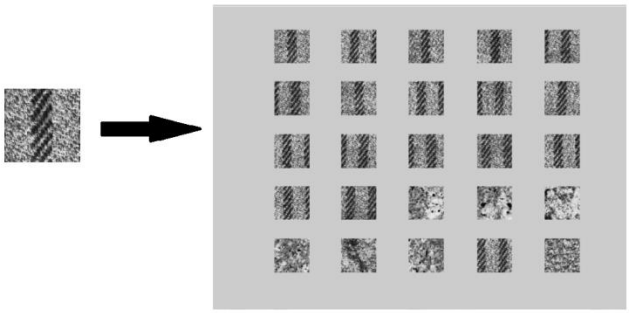


**Fig.: Vector cosine Angle Distance result.**

The table shows that time calculated for 3 distance matrices for retrieving of images using the Matlab software in which Manhattan distance gives the best result.

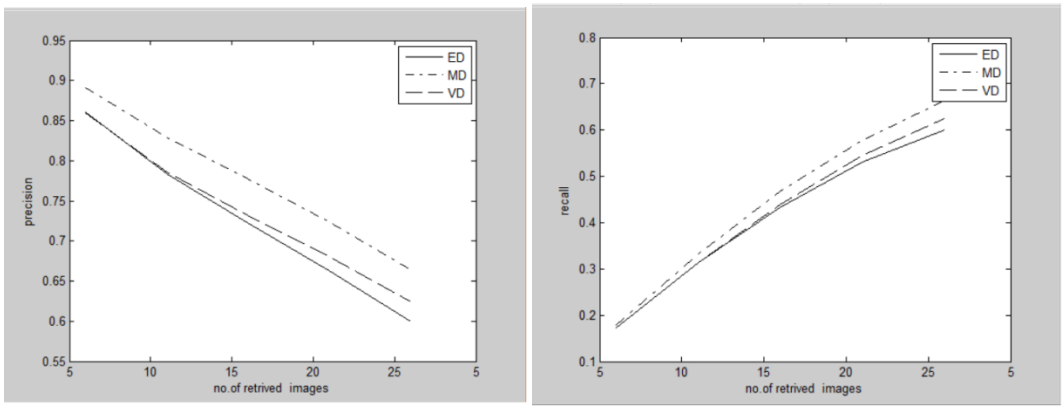
Table 5.1: Time Calculated

| **Distance Metrics** | **Texture retrieval time** |
|---|---|
| Euclidean Distance | 0.132 s |
| Vector Cosine Angle Distance | 0.125 s |
| Manhattan Distance | 0.115 s |

### 5.2 Results of Precision & Recall analysis

Graphical representation of Results of Precision & Recall analysis is as below which includes a comparison of 3 distance matrices.




(a) (b)

**Fig.: Graphical representation of No. of Retrieved Images vs. Precision and Graphical representation of No. of Retrieved Images Vs Recall.**

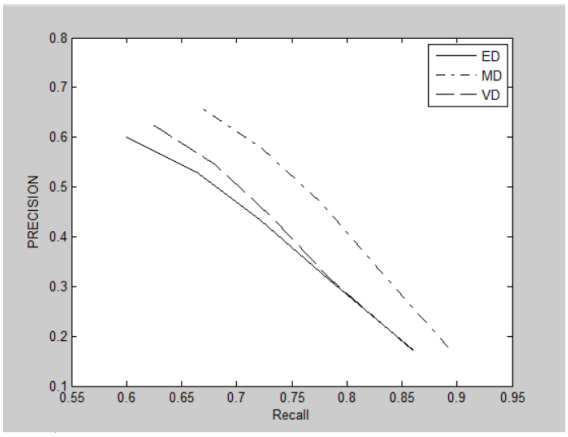



**Fig.: Graphical representation of Precision Vs Recall.**

Values obtained with Precision and recall for all three distance matrices are mentioned in the table below.

Table 5.2: Precision and Recall results

| No of retrieved Images | Precision in percentage | | | Recall in percentage | | |
|---|---|---|---|---|---|---|
| | ED | MD | VCAD | ED | MD | VCAD |
| 5 | 86.02 | 89.10 | 85.93 | 17.20 | 17.82 | 17.18 |
| 10 | 78.36 | 82.94 | 78.59 | 31.35 | 33.17 | 31.43 |
| 15 | 72.23 | 77.73 | 73.23 | 43.33 | 46.64 | 43.93 |
| 20 | 66.25 | 72.31 | 68.04 | 53.00 | 57.85 | 54.43 |
| 25 | 59.95 | 66.43 | 62.46 | 59.95 | 66.43 | 62.46 |

## CONCLUSIONS

We have done the comparative study of performance between the different types of distances like Euclidean, Manhattan, Vector Cosine Angle Distances for finding similarity between images.

1) By analysing the results of retrieved images, retrieving occur due to Manhattan Distances gives the more accurate result of images retrieved compared to other two distance matrices.

2) From Precision and Recall analysis it is again obtained that Manhattan Distance gives a good result.

3) The time required for retrieving for images is less using Manhattan distance.

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