

وزارة التعليم العالي والبحث العلمي

جامعة القادسية - كلية علوم الحاسوب وتكنولوجيا المعلومات

قسم علوم الحاسوب



استرجاع الصور باستخدام GLCM

دراسة تقدم بها

علاء خليل صعيب

صلاح سليم حطوط

حسنين صباح جاسم

إلى مجلس كلية علوم الحاسوب وتكنولوجيا المعلومات جامعة القادسية كجزء من
متطلبات نيل درجة البكالوريوس في علوم الحاسوب

تحت اشراف

د. لمياء عبد نور

٢٠١٧م ١٤٣٨هـ

الآية القرآنية

بسم الله الرحمن الرحيم

((قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ))

صدق الله العلي العظيم

سورة البقرة (٣٢)

الإهداء

إلى من أناروا الدنيا بنورهم سادتي فاطمة وأبيها وبعلمها وبنيتها (عليهم السلام)
والى رمز العمل ورمز الصبر معلمي الأول في الحياة
إلى من علمني إن بالحب يكبر الإنسان وبالعلم يتنور وبالإرادة تقهر الصعاب
إلى بحر العطاء دون حساب ... والدي العزيز
إلى من تعجز الكلمات ان توفيقها حقا وأجمل والسطور تسجد أمام عظمة تضحياتها
إلى الحروف المقدسة التي تشع حبا وعطفا
إلى نبع الحنان والملاك الساهر على راحتنا ... والدتي العزيزة
إلى من أبصرت بإحداقهم ضوء النهار
إلى من شاركوني ومازالوا أفرحي وأحزاني
وكانوا ومازالوا عوناً لي في مشواري
إلى من ملئوا دربي ورداً وقلبي حبا إخوتي وأخواتي

الباحثون

شكر وتقدير

الحمد لله كما ينبغي لجلال وجهه وجلال سلطانه . عدد خلقه . ومداد كلماته . وزنة عرشه ورضاء نفسه ، والصلاة والسلام على عباده الذين اصطفاهم وعلى خاتم الأنبياء والمرسلين سيدنا محمد (صلى الله عليه واله وسلم)

يدعوني واجب العرفان بالجميل ان أسجل عظيم شكري وبالف امتتاني لأستاذتي المشرفة الدكتورة لمياء عبد نور لما أبدته من توجيهات سديدة وأراء علميه رصينة فجزاها الله الخير الجزاء .

وأقدم بالشكر والامتنان الى الدكتور هشام علي البيرماني عميد كلية علوم الحاسوب وتكنولوجيا المعلومات و معاون العميد الدكتور وقاص غالب عطشان لدعمهم ورعايتهم المتواصلة لطلبة كلية علوم الحاسوب وتكنولوجيا المعلومات . وأقدم شكري الى رئاسة قسم علوم الحاسوب . لما أبدوه من توجيهات علميه ومساندة طيلة مدة الدراسة .

وأخيرا أقدم شكري واحترامي إلى كل من ساعدني أو أسدى لي معروفا أو شجعني بكلمة طيبة أو دعوة خالصة ...

أسأل الله أن يوفق الجميع لما يحب ويرضى فهو السميع العليم

الباحثون

CHAPTER ONE

INTRODUCTION:

Images play a crucial role in today's age of succinct information. The field of image processing has exhibited enormous progress over past few decades. Generally, the images dealt in virtual environments or entertainment applications possess high fidelity resulting in large storage requirements. Images may undergo distortions during preliminary acquisition process, compression, restoration, communication or final display. Hence image quality measurement plays a significant role in several image-processing applications. Image quality, for scientific and medical purposes, can be defined in terms of how well desired information can be extracted from the image. An image is said to have acceptable quality if it shows satisfactory usefulness, which means discriminability of image content, and satisfactory naturalness, which means identifiability of image content. Digital storage of images has created an important place in imaging. Image quality metrics are important performance variables for digital imaging systems and are used to measure the visual quality of compressed images. The three major types of quality measurements are

1-1 MATLAB :

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

Math and computation

Algorithm development

Modeling, simulation, and prototyping

Data analysis, exploration, and visualization

Scientific and engineering graphics

Application development, including Graphical User Interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar noninteractive language such as C or Fortran.

The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects, which together represent the state-of-the-art in software for matrix computation.

MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

MATLAB features a family of application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow you to learn and apply

specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

The MATLAB System

The MATLAB system consists of five main parts:

The MATLAB language.

This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object-oriented programming features. It allows both "programming in the small" to rapidly create quick and dirty throw-away programs, and "programming in the large" to create complete large and complex application programs.

1-1-2 The MATLAB working environment.

This is the set of tools and facilities that you work with as the MATLAB user or programmer. It includes facilities for managing the variables in your workspace and importing and exporting data. It also includes tools for developing, managing, debugging, and profiling M-files, MATLAB's applications.

Handle Graphics.

This is the MATLAB graphics system. It includes high-level commands for two-dimensional and three-dimensional data visualization, image processing, animation, and presentation graphics. It also includes low-level commands that allow you to fully customize the appearance of graphics as well as to build complete Graphical User Interfaces on your MATLAB applications.

1-1-3 The MATLAB mathematical function library.

This is a vast collection of computational algorithms ranging from elementary functions like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigenvalues, Bessel functions, and fast Fourier transforms.

1-1-4 The MATLAB Application Program Interface (API).

This is a library that allows you to write C and Fortran programs that interact with MATLAB. It includes facilities for calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files.

1-1-5 The Language of Technical Computing :

Millions of engineers and scientists worldwide use MATLAB® to analyze and design the systems and products transforming our world. MATLAB is in automobile active safety systems, interplanetary spacecraft, health monitoring devices, smart power grids, and LTE cellular networks. It is used for machine learning, signal processing, image processing, computer vision, communications, computational finance, control design, robotics, and much more.

1-1-6 Math. Graphics. Programming.

The MATLAB platform is optimized for solving engineering and scientific problems. The matrix-based MATLAB language is the world's most natural way to express computational mathematics. Built-in graphics make it easy to visualize and gain insights from data. A vast library of prebuilt toolboxes lets you get started right away with algorithms essential to your domain. The desktop environment invites experimentation, exploration, and discovery. These MATLAB tools and capabilities are all rigorously tested and designed to work together.

1-1-7 Perform image processing, analysis, and algorithm development :

Image Processing Toolbox™ provides a comprehensive set of reference-standard algorithms, functions, and apps for image processing, analysis, visualization, and algorithm development. You can perform image analysis, image segmentation, image enhancement, noise reduction, geometric transformations, and image registration. Many toolbox functions support multicore processors, GPUs, and C-code generation.

Image Processing Toolbox supports a diverse set of image types, including high dynamic range, gigapixel resolution, embedded ICC profile, and tomographic. Visualization functions and apps let you explore images and videos, examine a region of pixels, adjust color and contrast, create contours or histograms, and manipulate regions of interest (ROIs). The toolbox supports workflows for processing, displaying, and navigating large images.

CHAPTER TWO

2-1 GLCM :

A statistical method of examining texture that considers the spatial relationship of pixels is the gray-level co-occurrence matrix (GLCM), also known as the gray-level spatial dependence matrix. The GLCM functions characterize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship occur in an image, creating a GLCM, and then extracting statistical measures from this matrix. (The texture filter functions, described in Texture Analysis cannot provide information about shape, i.e., the spatial relationships of pixels in an image.)

2-2 Gray-Level Co-occurrence Matrices (GLCMs) :

Consider the image (below left). If we use the position operator “1 pixel to the right and 1 pixel down” then we get the gray-level co-occurrence matrix (below right)

$$\begin{array}{ccccc} 0 & 0 & 0 & 1 & 2 \\ 1 & 1 & 0 & 1 & 1 \\ 2 & 2 & 1 & 0 & 0 \\ 1 & 1 & 0 & 2 & 0 \\ 0 & 0 & 1 & 0 & 1 \end{array} \quad C = \frac{1}{16} \begin{bmatrix} 4 & 2 & 1 \\ 2 & 3 & 2 \\ 0 & 2 & 0 \end{bmatrix}$$

where an entry c_{ij} is a count of the number of times that $F(x, y) = i$ and $F(x + 1, y + 1) = j$. For example, the first entry comes from the fact that 4 times a 0 appears below and to the right of another 0. The factor $1/16$ is because there are 16 pairs entering into this matrix, so this normalizes the matrix entries to be estimates of the co-occurrence probabilities .

For statistical confidence in the estimation of the joint probability distribution, the matrix must contain a reasonably large average occupancy level. Achieved either by (a) restricting the number of amplitude

quantization levels (causes loss of accuracy for low-amplitude texture), or (b) using large measurement window.

(causes errors if texture changes over the large window). Typical compromise: 16gray levels and window size of 30 or 50 pixels on each side. Now we can analyze C:

- maximum probability entry
- element difference moment of order k : $\sum_i \sum_j (i - j)^k c_{ij}$

This descriptor has relatively low values when the high values of C are near the main diagonal.

For this position operator, high values near the main diagonal would indicate that bands of constant intensity running “1 pixel to the right and 1 down” are likely. When $k = 2$, it is called the contrast:

- Contrast $= \sum_i \sum_j (i - j)^2 c_{ij}$
- Entropy $= - \sum_i \sum_j c_{ij} \log c_{ij}$

This is a measure of randomness, having its highest value when the elements of C are all equal.

In the case of a checkerboard, the entropy would be low.

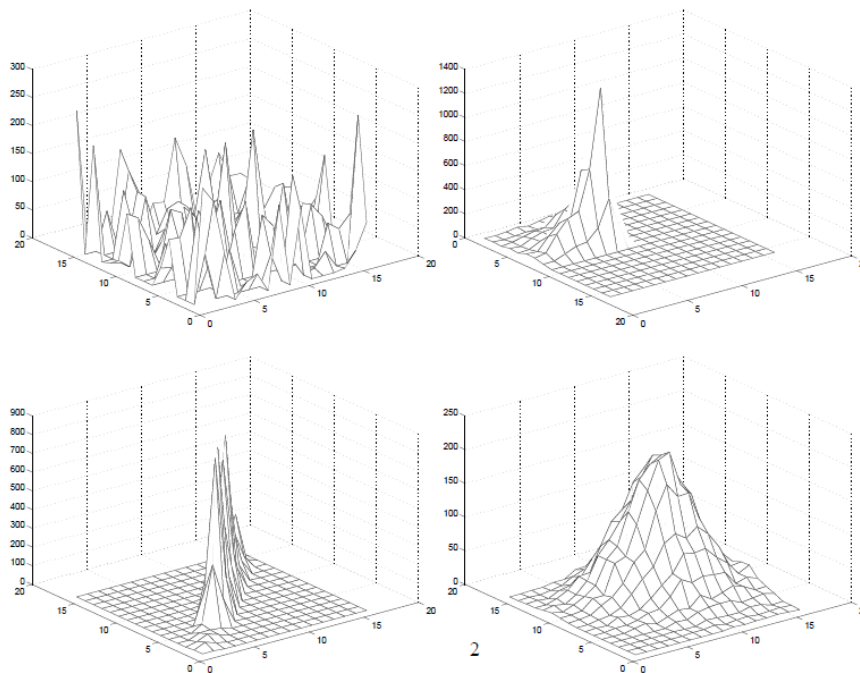
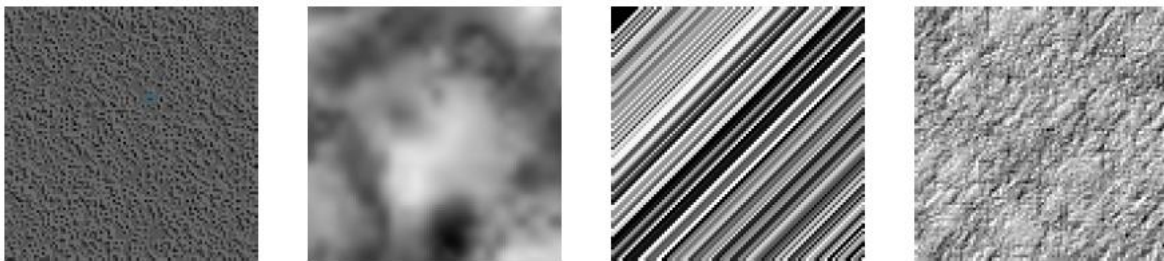
$$\begin{array}{ccccc}
 0 & 1 & 0 & 1 & 0 \\
 1 & 0 & 1 & 0 & 1 \\
 0 & 1 & 0 & 1 & 0 \\
 1 & 0 & 1 & 0 & 1 \\
 0 & 1 & 0 & 1 & 0
 \end{array}
 \rightarrow
 \begin{array}{cc}
 8 & 0 \\
 0 & 8
 \end{array}$$

- Uniformity (also called Energy) $= \sum_i \sum_j c_{ij}^2$ (smallest value when all entries are equal)
- Homogeneity $= \sum_i \sum_j \frac{c_{ij}}{1 + |i - j|}$ (large if big values are on the main diagonal)

Problems associated with the co-occurrence matrix methods:

- 1. they require a lot of computation (many matrices to be computed)*
- 2. features are not invariant to rotation or scale changes in the texture*

Sample Question on GLCMs Here are 4 different texture patches of size 96x96 pixels. All the pixels in the patch (quantized to 16 levels) were used to form GLCMs shown below. The position operator was “one down and one to the right.” Decide which texture patch gave rise to each GLCM. Note that 3 of the plots show perspective views of the GLCM from the vantage point of the (0,0) position. However, one of the plots has the (0,0) matrix coordinate position placed in the upper left corner since that provides a better view. So check the axis labels.



2

2-3 Retrieval Using GLCM

Recently, huge collections of images have grown rapidly. Corresponding to this growth, Content based image retrieval are required to access visual information. As powerful technique, content based image retrieval systems have to provide easily data structures indexing and faster query execution facilities. The CBIR system retrieves relevant images from an image collection based on automatic derives features. The derived features include primitive features such as texture, color, and shape.

Texture is one of important primitives in human vision and texture features have been used to identify content of images. Texture is a property that represents the surface and structure of an Image. In general, Texture can be defined as a regular repetition of elements or patterns on a surface. Image texture are complex visual pattern that consisting of entities or areas with sub-pattern with characteristic brightness, color, shape, size, etc. An image region has a constant texture if a set of its characteristics are constant, slowly changing or approximately periodic [8].

Texture contains important information about the structural arrangement of surfaces. The textural features based on gray-tone spatial dependencies have a general applicability in image classification [3]. Texture can be considered as repeated patterns of pixels over a spatial domain. The repetition frequencies results in textures can appear to be random and unstructured. A number of techniques have been used for measuring the texture features such as Gabor filter, fractals, wavelets, co-occurrence matrix etc.

Texture features are extracted based on GLCM (Gray Level Co-occurrence Matrix). The Gray Level Co-occurrence Matrix (GLCM) is a statistical method of examining texture that considers the spatial relationship of pixels [4], [6]. GLCM contains information about the position of the pixels that have the same value of gray levels. A GLCM is a 2- dimensional array, P , in which both rows and columns representing a set of possible values of the image [4], [6].

There are several studies proposed content based image retrieval using texture feature. Ramamurthy and Chandran proposed texture based image retrieval using GLCM and K-Means clustering [1]. The retrieval results have high precision value. Sebastian, et al also proposed texture based image retrieval using GLCM [9]. The retrieval results are effective. However both studies have not used local analysis. Using local analysis the query image and database image are divided into several

sub-blocks. Each image sub-block query is compared with all of image sub-blocks database therefore the retrieval result could be better than using global analysis. This paper presents a texture based image retrieval using GLCM and image sub-block. The rest of paper consists of: Section II describes the proposed method.

Section III presents the experimental results. Finally, Section IV describes the conclusions.

2-3-1 A. Method

The scheme of method in this experiment is described as follows:

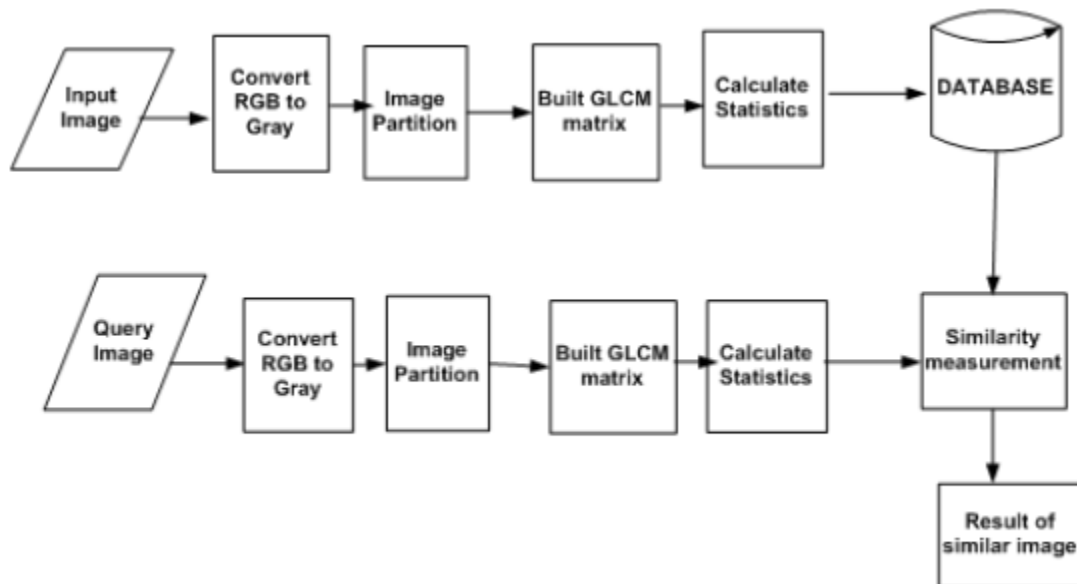


Fig. 1 Scheme of image retrieval

Method scheme of texture image retrieval using GLCM and image sub-block has two stages. The first stage is image

feature extracting and the second stage is image retrieval. Fig. 1 represents the first stage that is a feature vector is

extracted from each image in the database and the set of all feature vectors is organized as a database index. As can be

seen in fig. 1, while an image query is selected, the RGB color space is converted to gray. The next step is the image is

divided into three column and three rows in equal size. Texture feature for each sub block is extracted based on GLCM

(Gray Level Co-occurrence Matrix). The sub-block image is analyzed by using four statistic features. The Statistic

features used are contrast, homogeneity, energy and correlation. These four features are computed in four directions (00,

450, 900, and 1350). Therefore 16 texture values are computed in each image sub-block.

In stage 2, extraction process is the same with stage 1, however in this stage after calculating statistics using four

statistic features and four directions, the similarity measurement is computed. Each image sub-block query is computed

with every image sub-block database using Euclidean distance and city Block distance. Therefore, each image sub-block

query is compared with all of image sub-blocks database. The retrieved image are then ranked according to the relevance

between the query image and images in the database in proportion to a similarity measure computed from the features.

B. Gray Level Co-occurrence Matrix (GLCM)

Texture representation methods can be classified into two categories: structural and statistical. Structural methods

describe the texture by identifying the primitive structure and rules of their placement. Statistical methods characterize

texture by the statistical distribution of the image intensity [7].

The Gray Level Co-occurrence Matrix (GLCM) is a statistical method of examining texture that considers the spatial

relationship of pixels [4], [6]. GLCM contains information about the position of the pixels that have the same value of

gray levels. A GLCM is a 2-dimensional array, P , in which both rows and columns representing a set of possible values

of the image [4], [6]. It is a matrix showing how often a pixel with intensity (gray-level) value i occurs in a specific

spatial relationship to a pixel with the value j . It is defined by $P(i,j|d,\Theta)$, which expresses the probability of the couple of

pixels at Θ direction and d interval. Once the GLCM is created various features can be computed from it [4], [6].

In order to estimate the similarity between different gray level co-occurrence matrices, Haralick had proposed 14

different statistical features extracted from GLCM [2], [3], [6]. To reduce the computational complexity, only some of

these features are selected in this paper, specifically: Energy, Contrast, Homogeneity and Correlation.

The four statistics applied to co-occurrence probabilities are discussed before

1) Energy :

This statistic measures the uniformity of texture that is pixel pair repetitions. It detects disorders in textures. Energy

reaches a maximum value that equal to one. High energy values occur when the gray level distribution has a constant or

periodic form. Energy has a normal range. The GLCM of less homogeneous image will have large number of small

entries [4], [6].

2) Contrast :

This statistic measures the spatial frequency of an image and is difference moment of GLCM. It is the difference between

the highest and the lowest values of a set of adjacent pixels. It measures the amount of local variations present in the

image. A low contrast image presents GLCM concentration term around the main diagonal and low spatial frequency

features [4], [6].

3) Homogeneity :

This statistic measures image homogeneity as it assumes larger values for smaller gray tone differences in pair

elements. It is more sensitive to the presence of near diagonal elements in the GLCM. It has maximum value when all

elements in the image are equal. GLCM contrast and homogeneity are strongly, but inversely, correlated in terms of Mustikasari et al., International Journal of Advanced Research in Computer Science and Software Engineering 5(3),

equivalent distribution in the pixel pairs population. It means homogeneity decreases if contrast increases while energy is kept constant [4], [6].

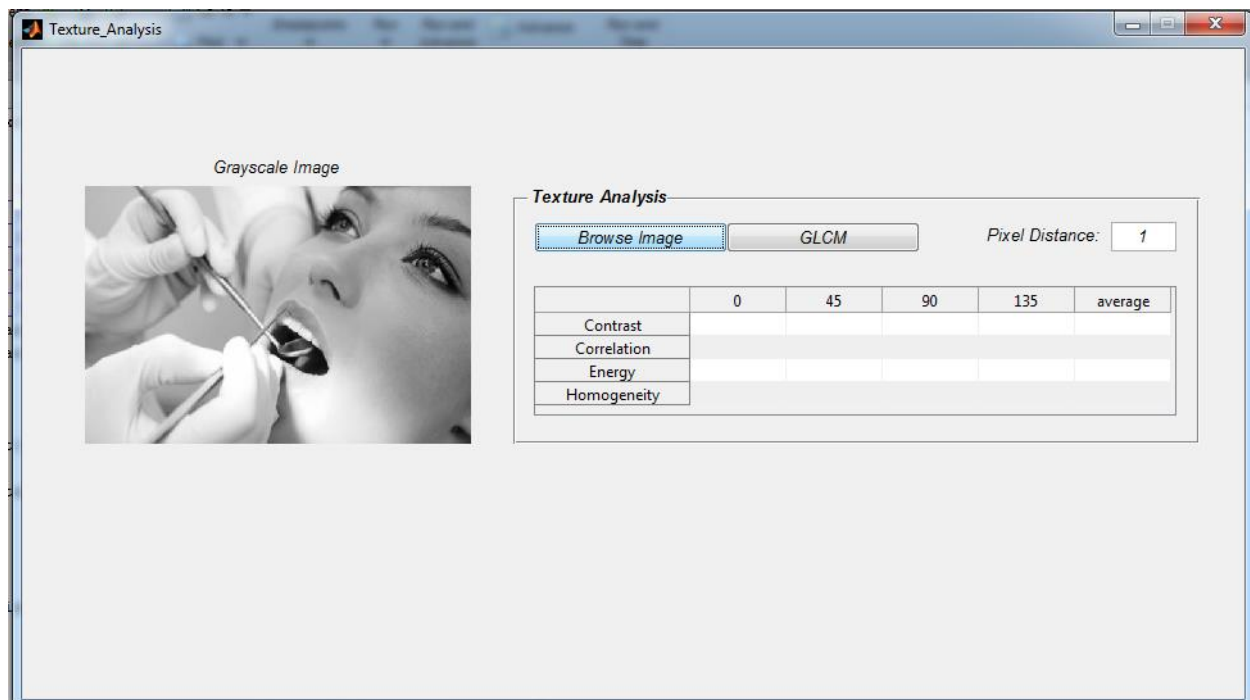
CHAPTER THREE

3-1 Scientific department:

1- For first we use this Image

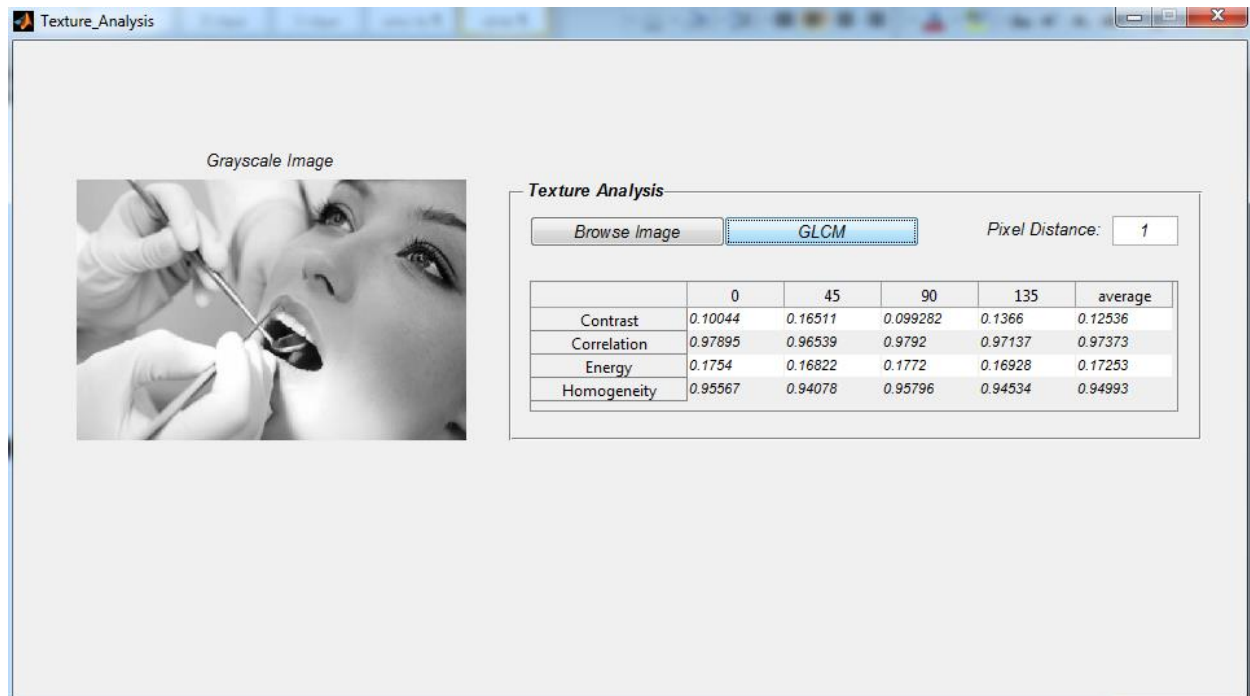


2- insert Image to Program (Browse Image)



Program convert image to Gray

3- press GLCM bottom



The result

	0	45	90	135	average
Contrast	0.10044	0.16511	0.099282	0.1366	0.12536
Correlation	0.97895	0.96539	0.9792	0.97137	0.97373
Energy	0.1754	0.16822	0.1772	0.16928	0.17253
Homogeneity	0.95567	0.94078	0.95796	0.94534	0.94993

Resources

- [1] B. Ramamurthy, Chandran K.R., "Content Based Medical Image Retrieval with Texture Content Using Gray Level Co-occurrence Matrix and K-Means Clustering Algorithms", *Journal of Computer Science* 8 (7): 1070-1076, ISSN 1549-3636, 2012.
- [2] Eleyan, A., Demirel, H., "Co-occurrence matrix and its statistical features as a new approach for face recognition", *Turk J Elec Eng & Comp Sci*, Vol.19, No.1, 2011.
- [3] Gadkari D., "Image Quality Analysis Using GLCM", A thesis submitted in partial fulfillment of the requirements for degree of Master of Science in Modeling and Simulation in the College Arts and Sciences at the University of Central Florida. B.S.E.E University of Pune, 2000.
- [4] Howarth P., Ruger S., "Evaluation of Texture Features for Content-Based Image Retrieval", P. Enser et al. (Eds.): *CIVR 2004*, LNCS 3115, pp. 326–334, 2004.
- [5] Missaoui R. Sarifuddin M. and Vaillancourt J., "An Effective Approach Towards Content-Based Image Retrieval", *CIVR.*, 2004, pp.335-343, 2004.
- [6] R.M. Haralick, K. Shanmugam, and I.H. Dinstein. Textural features for image classification. *IEEE Transactions on Systems, Man, and Cybernetics*, pages 237-247, 1973.
- [7] Rao N. G., Kumar V. Vijaya., Krishna V. Venkata., "Texture Based Image Indexing and Retrieval", *IJCSNS International Journal of Computer Science and Network Security*, VOL.9 No.5, 2009.
- [8] Srinivasan G. N., G. Shobha., "Statistical Texture Analysis", *Proceedings Of World Academy Of Science, Engineering And Technology* Vol.36, ISSN 2070-3740, 2008.
- [9] V. Bino Sebastian., Unnikrishnan, A., Balakrishnan, K., "Grey level co-occurrence matrices: generalisation and some new features", *International Journal of Computer Science, Engineering and Information Technology (IJCEIT)*, Vol.2, No.2, 2012.