CONTENT-BASED IMAGE RETRIEVAL FOR MEDICAL IMAGING USING IRMA DATASET

By

Ayat Youssef Mohammed Foad Helmy

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
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Title of Thesis:

Content-based image retrieval for medical imaging using IRMA dataset

Key Words:
Content-based image retrieval; X-ray; Local Binary Pattern, Mesh Local Binary Pattern

Summary:

Content-Based Image Retrieval (CBIR) for medical imaging helps in efficient diagnosis and treatment planning can be supported by developing retrieval systems to provide high-quality healthcare. In this thesis, different approaches are proposed using IRMA dataset in each block of the CBIR system, And this includes pre-processing, image enhancement as Contrast Limited Adaptive Histogram Equalization (CLAHE), median filter and gamma correction, feature extraction method as Local Binary Pattern (LBP) and Mesh Local Binary Pattern (MLBP) with different configurations and for the retrieval different methods as Support Vector Machine (SVM), Locality Sensitive Hashing (LSH),Fisher Discriminant Analysis (FDA), Linear Fisher Discriminant Analysis (LFDA), using fusion of them and by using conventional similarity based learning as Euclidean, Mahalanobis, Spearman, Correlation and Hamming Distance. And the evaluation is done using the specific evaluation of IRMA dataset. This thesis gives a detailed implementation for each mentioned step.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Date:

Signature:

Acknowledgments

First and foremost, I thank **ALLAH**, the most gracious, the ever merciful for helping me finishing this work.

I want to thank all those, who helped me by their knowledge and experience. I will always appreciate their efforts. I would like to offer my sincere thanks to my supervisors **Prof. Dr. Ayman Eldeib, Assoc. Prof. Dr. Inas A. Yassine** and **Dr. Muhammad Rushdi.** I owe them for valuable supervision, continuous encouragement, useful suggestions, and active help during this work. My sincere appreciation and gratitude to my family for their help and patience during the preparation of this work,

Dedication

I want to dedicate my thesis to my mother 'God Bless her soul'. I know that you will be proud of me as you were when I graduated from university. I wish you are here to attend my defense.

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Nomenclature

BKS	Behavioral Knowledge Space
CBIR	Content-Based Image Retrieval
CLAHE	Contrast Limited Adaptive Histogram Equalization
CNN	Convolutional Neural Network
CT	Computed Tomography
FDA	Fisher Discriminant Analysis
GC	Gamma Correction
ImageCLEF	Image Cross Language Evaluation Forum
IR	Image Retrieval
IRMA	Image Retrieval in Medical Applications
k-NN	K- Nearest Neighbor
LBP	Local Binary Pattern
LFDA	Local Fisher Discriminant Analysis
LSH	Locality Sensitive hashing
MLBP	Mesh Local Binary Pattern
MRI	Magnetic Resonance Imaging
RBF	Radial Basis Function
SAE	Stacked Auto-Encoder
SIANN	Space Invariant Artificial Neural Network
SVM	Support Vector Machine

Abstract

Content-Based Image Retrieval (CBIR) become one of the most active areas in medical image analysis in the last two decades because of the steadily increase in the number of digital images used. Efficient diagnosis and treatment planning can be supported by developing retrieval systems to provide high-quality healthcare. Extensive research has attempted to improve the image retrieval efficiency. The critical factors when searching in large databases are time and storage requirements. In general, although many methods have been suggested to increase accuracy, fast retrieval has been rather sporadically investigated.

In this thesis, different approaches are proposed to reduce the computation complexity in terms of both the processing time and memory space requirements used for saving our database to be used in medical image retrieval. The dataset used is Image Retrieval in Medical Applications (IRMA) which contains 14,410 X-ray images labeled as IRMA coding the Image modality, body orientation, body region and biological system. A pre-processing module was used to prepare the dataset for further analysis, this module includes resizing, removal of the unrelated landmarks, as well as image enhancement algorithms, including gamma correction, median filter and Contrast Limited Adaptive Histogram Equalization (CLAHE). Second module in our pipeline is the feature extraction, Local Binary Pattern (LBP) and Mesh Local Binary Pattern (MLBP) histogram-based features were extracted from IRMA dataset. In the similarity measurement, the on learning based as distance based were employed. The learning-based algorithm prove outperformed the distance-based measures. Locality Sensitive hashing (LSH), Fisher Discriminant Analysis (FDA) and Local Fisher Discriminant Analysis (LFDA) employed the extracted features along with their corresponding image category labels to build a Support Vector Machine (SVM) classifier. Subsequently, the k-nearest neighbor search method is applied to find the images with minimum distance of the LBP and MLBP within the same class predicted by the trained SVM classifier and voting between them by using LBP and MLBP features. The performance of the retrieval process is evaluated using IRMA score, provided by Image CLEF to compute the error between the IRMA codes of the testing images. The SVM approach scored IRMA error score of 240 using MLBP with parameters of 8 neighbors and radius equal 1, using pre-processing and gamma correction as image enhancement algorithm that boosted the results from with the raw image that error scored 319. While the best IRMA error score using LSH is 362, using FDA is 405 and using LFDA is 347. By comparing the results, SVM scores boosted performance by 1.69% from FDA results. These results demonstrate that SVM method has the capacity to retrieve similar responses for the correctly identified query image and even for those mistakenly classified by SVM.

Chapter 1 : Introduction

With rapid growth of computer technologies, digitized information has gained tremendous interest for more than two decades. Since the steadily increasing amount of information has been made easily accessible through digital media, navigation and retrieving accurate and relevant information from big data has become one of the most important problems in information technology. Images are utilized in many application fields such as biomedicine, crime prevention, architecture, engineering, military, commerce, education and entertainment. Imaging provides important support in these areas. Especially in medicine, imaging constitutes a very fast and non-invasive method for diagnosis, treatment and monitoring of different disease. The digitization of images as the first factor, comes in a prominent position due to its benefits in many areas as commerce, crime investigation and medical field [1].

Also, the presence of internet, the second factor that makes it possible for the human kind to access this huge amount of information easily. These two factors are highly significant for the medical field. Medical imaging, with the advancement of multimedia and imaging technology became one of the most important components in clinical diagnosis, by seeking to reveal internal structures hidden by the skin and bones. The substantiality, to acquire similar images in various modalities in various stages of the disease progression, is for the process of clinical decision-making. For this reason, the need for an efficient and accurate information retrieval system has increased and attracted much interest among the researchers in recent years. Also, the existence of large number of medical image databases makes it an urgent need for a system of Image Retrieval (IR). There are two kinds of medical image retrieval systems, namely text-based and content-based methods [1,2].

1.1. Text Based Image Retrieval (TBIR)

Text Based Image Retrieval (TBIR) can be traced back to the late 1970s. TBIR is used to manually annotate the image in the database with annotations, keywords, or descriptions. So, images are labeled by taking advantage of keywords, classification codes or subject heading to search and retrieve images. This process is used to describe both image contents and other metadata of the image such as: image file name, image and image format, image size and image dimensions. Then, the user formulates textual or numeric queries to retrieve all images that are satisfying some of the criteria based on these annotations[3], as shown in Figure1.1[4].

Using these textual labels, retrieval can be easily and quickly applied. However, there are some drawbacks in TBIR. The first drawback is that the most descriptive annotations must usually be entered manually by human operators. Manually annotation for a large image database is impractical, as entering keywords for images in a large database manually can be expensive, time consuming, inefficient, and may not capture the perfect word that describes the image. The annotator may give different descriptions to images with similar visual contents. Also, textual annotations are language dependent. As well, this method cannot prevent incorrect or missing results based on mistakenly labeled images. The second drawback is that the most images are