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Image Retrieval: Information and Rough Set Theories

Rama Murthy Garimella^{a,*}, Moncef Gabbouj^b and Iftikhar Ahmad^b

^aDepartment of Signal Processing, IIIT—Hyderabad, India

^bDepartment of Signal Processing, Tampere University of Technology, Finland

Abstract

In this research paper, we propose novel features based on information theory for image retrieval. We propose the novel concept of “probabilistic filtering”. We propose a hybrid approach for image retrieval that combines annotation approach with content based image retrieval approach. Also rough set theory is proposed as a tool for audio/video object retrieval from multi-media databases.

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1. Introduction

With the advent of audio, video recording technologies, every day large collection of images are generated by various organizations. Thus, to access and utilize the information, there is increasing need to organize it in a manner that allows efficient browsing, searching and retrieval. The Data Base Management (DBMS) and computer vision research communities study image retrieval from different angles, one being text-based and the other being visual based.

In the text based image retrieval approach, the images are first annotated by text and then use text based DBMS to perform image retrieval. In this research direction many advances such as data modeling, multi-dimensional indexing and query evaluation are proposed. However, when the size of image collection is large (millions of images), the annotation based approach presents two difficulties: (i) amount of labor required for manual image annotation, (ii) rich content in images and subjectivity of human perception. As the size of image collection became large, the above two difficulties became more and more acute. To overcome these difficulties, Content Based Image Retrieval (CBIR) was proposed. In this approach, images would be indexed by their own visual content such as color, texture etc. In CBIR, there are three main tasks: Visual feature extraction, Multi-dimensional indexing and retrieval system design.

There are two types of features: text based features (keywords, annotation etc.) and visual features (color, texture, shape, objects etc.). There is a rich literature on text-based feature extraction in DBMS and Information Retrieval (IR) research communities. Visual feature extraction involves general features (such as color, texture, shape etc.) and domain specific features (such as human faces, finger prints, gestures etc.). In this research paper, we argue that a “hybrid” approach based on annotation of groups of images and CBIR enables “faster” image retrieval and scalable to

*Corresponding author.

E-mail address: rammurthy@iiit.ac.in

“incremental” image collections. Also, we propose some interesting novel features associated with image histogram. Further rough set based approach to object (audio, video) retrieval in multi-media databases is discussed.

This research paper is organized as follows. In Section 2, some novel features associated with images are discussed. Hierarchical features are proposed for fast image retrieval. In Section 3, an interesting and promising hybrid approach for image retrieval is proposed (that combines the annotation based approach with CBIR). In Section 4, rough set theory is proposed as a tool for audio/video object retrieval in multi-media databases. The research paper concludes in Section 5.

2. Motivation and Literature Survey

The research area of CBIR has been subjected to intense research efforts by the Computer Vision and other research communities. One of the central topics in that effort deals with extraction of similarity measures between images. Effectively most of the approaches are based on extraction of discriminatory features from the images. Features based on texture information⁶ are also very popular^{3,4}.

Histogram is one of the effective summaries of pixel intensity distribution over the image traditionally researchers proposed arriving at a normalized histogram (to be explained in the next section). It also provides a non-parametric statistical summary of information in an image. Once such a statistical summary is available, researchers effectively relied on computing moments as well as central moments (using the normalized histogram). Such quantities were utilized to determine the similarity measures.

3. Image Retrieval: Information Theory

- To the best of our knowledge, in the image retrieval literature, no one has “thoroughly” investigated the utilization of information theoretic similarity measures associated with the normalized histogram. In this research paper, we propose to contribute to that effort. Also, we propose the idea of investigating the effect of change of bin size on the normalized histogram.
- Utilizing the fact that normalized histogram constituted a probability mass function, various coarse grain, fine grain features of utility in image retrieval are proposed.
- Given the fact that histogram is affected by various forms of noise (such as impulsive noise), we propose to counter its affects. The concept of “PROBABILISTIC FILTERING” is proposed.
- As in the case of information theory, the effect of noise on the image is captured using an IMAGE CHANNEL MATRIX. The mutual information associated with such a matrix provides the “channel capacity”.

4. Audio/Video Object Retrieval from Databases: Rough Set Theory

- The concept of rough set was proposed to extract information from the information table in databases. In recent years, the technological idea of “multi-media” databases was proposed. There are several implementations of such databases. It is realized by the authors that the uncertainty associated with audio/video retrieval from multi-media databases is best captured using the concept of rough set. Thus, we propose rough set theory based approaches to retrieve desired information from such databases. To our knowledge rough set theoretic framework for audio/video retrieval from multi-media databases has not been “thoroughly” investigated in the literature.
- It is expected that powerful tools developed in rough set theory could be invoked for audio/video object retrieval from multi-media databases.

5. Extraction of Novel Hierarchical Features

In designing and building web-scale CBIR engines, it is necessary to be able to compute and decide the similarity between images as fast as possible. Thus, through utilization of coarse grain features to fine grain features, the vast collection of images (in the data base) are searched for similarity as fast as possible.

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