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A STRATEGIC APPROACH FOR ENHANCING RETRIEVAL PERFORMANCE OF CONTENT BASED IMAGE RETRIEVAL SYSTEM BASED USING FUSION TECHNIQUES

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ABSTRACT

Content-Based Image Retrieval (CBIR) systems are designed to fetch images from a repository or database that are visually comparable to a given query image. CBIR is crucial in numerous domains including medical diagnosis, crime prevention, online searches, and architecture. The process of CBIR mainly involves two phases: the first involves feature extraction, and the second focuses on similarity matching. There are various approaches to enhance the efficiency and effectiveness of CBIR, including segmentation, relevance feedback, query expansion, and fusion techniques

Keywords: Content-Based Image Retrieval, Feature Extraction, Fusion Technique

I. INTRODUCTION

There are two potential approaches for searching extensive image databases; the first, which is outdated and inadequate, is text-based image retrieval (TBIR), where images are manually labeled with appropriate titles; this metadata is linked to images, and users later utilize keywords to seek and retrieve the desired images. This method has two significant drawbacks; the first issue is clear, as the manual labeling process demands a considerable amount of time, while the second drawback places a heavy burden on the user to formulate their own queries. A more efficient and effective alternative is content-based image retrieval (CBIR); this method offers numerous advantages that address the primary issues identified with TBIR. Additionally, CBIR has emerged as the primary method and a focal point of extensive research over the past two decades, driven by the rapid growth of multimedia data through contemporary sources such as the Internet, smart devices, Internet of Things (IoT) technologies, social networks, and medical imaging sources. Earlier CBIR research primarily focused on individual feature descriptors derived from color, texture, or shape; however, relying on a single feature space often fails to yield optimal retrieval results. Consequently, much of the recent research has concentrated on integrating multiple descriptors from the aforementioned categories. An early review of the wide array of application areas for CBIR has been documented.

Early fusion involves merging image features from several descriptors into a single vector before similarity calculations, whereas late fusion involves either consolidating outputs from different retrieval systems or combining various similarity rankings. In this study, a combination of color and texture features is proposed for use in both types of fusion strategies. Initially, a combination of eighteen color attributes and twelve texture attributes is merged into a unified vector representation. Following that, three of the most prevalent distance metrics are utilized during the late fusion stage. Our experimental findings on two widely-used image datasets indicate that our suggested method demonstrates strong retrieval performance when compared to the conventional approach of using a single feature descriptor, while also achieving satisfactory retrieval results in comparison to some leading-edge methods.

Automatic image retrieval has emerged as a significant research challenge, especially given its importance in managing and retrieving vast amounts of unlabelled gigabyte-sized image data that are generated and stored digitally in extensive databases. This data contains visual information available both online and within network computing systems. The traditional retrieval approach, known as text-based image retrieval (TBIM), relies on text and images for both storage and retrieval processes. However, this method has fallen out of favor due to the manual labor involved, which comes with two primary drawbacks. Firstly, obtaining accurate textual information about these images is often challenging, complicating the creation of effective image retrieval systems. Secondly, this can pose a substantial issue for the associate editor overseeing the review and approval

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of this manuscript. Collections labeled manually can suffer from inconsistencies, as a human annotator may overlook a specific definition of an image or might disagree with another individual's interpretation of its "correct" meaning

II. METHODOLOGY

2.1 Early Fusion Techniques

Early fusion techniques involve indexing methods that first extract unimodal features. Once these features are analyzed across various unimodal streams, they are combined into a single representation. After merging unimodal features into a multimodal representation, early fusion techniques utilize supervised learning to categorize semantic concepts. This approach can produce a genuinely multimedia feature representation, as all features are integrated from the outset. An additional benefit of early fusion is that it necessitates only one learning phase. However, a notable disadvantage is the difficulty in merging all features into a unified representation.

2.2 Late Fusion Techniques

The late fusion approach to multimedia combines the TBIR and CBIR subsystems, meaning it integrates both systems. This method results in decisions presented as numerical similarities (probabilities or scores), with the probabilities being merged or fused through aggregation functions. Late fusion algorithms generally outperform early fusion ones. One specific technique known as image re-ranking retrieves a ranked set of objects from the textual subsystem, followed by a reordering of these objects based on their visual scores (Pi). The CBIR subsystem calculates the visual scores (Pi) based solely on the selected objects from the TBIR subsystem.

2.3 Dataset

The Corel-1K and GHIM-10K datasets were utilized in this study. The Corel-1K dataset is divided into ten distinct categories: Africans, Beaches, Buildings, Buses, Dinosaurs, Elephants, Flowers, Horses, Mountains, and Food. Each category contains 100 images with resolutions of either 256×384 or 384×256 pixels. The second dataset, GHIM-10K, comprises 10,000 images, making it ten times larger than Corel-1K. This dataset is considered more challenging and diverse, containing images grouped into 20 categories, each consisting of 500 images with resolutions of 300×400 or 400×300 pixels. The categories include semantic labels such as sunsets, bikes, forts, ships, flies, cars, and others.

III. MODELING AND ANALYSIS

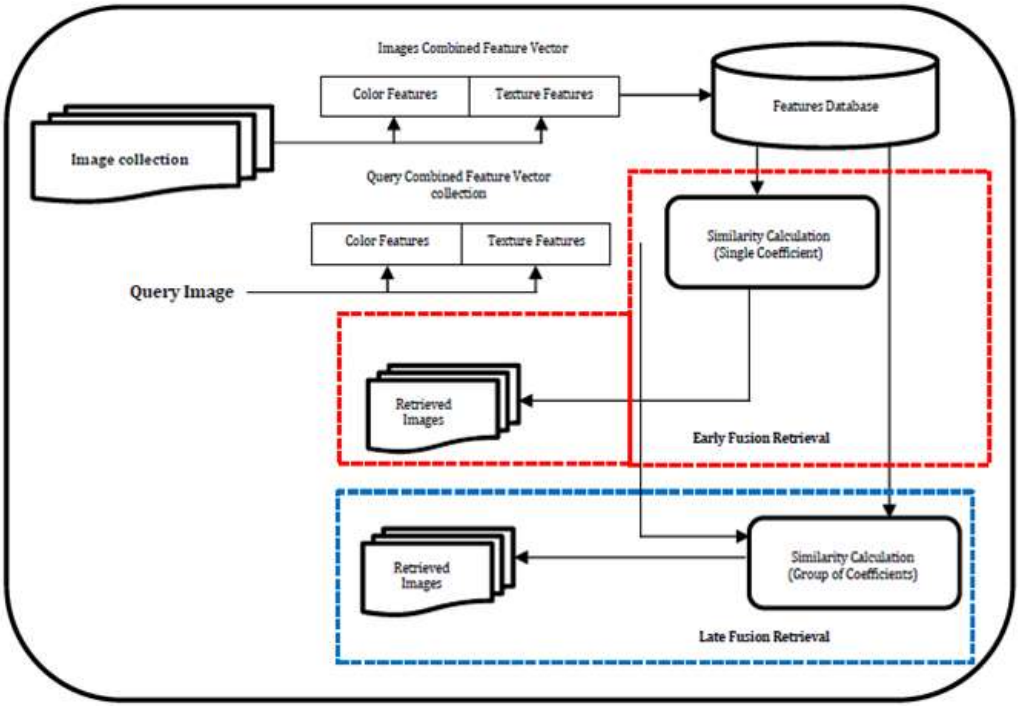

Figure 1: Proposed System Architecture.

Content-based image retrieval (CBIR) is a technique for retrieving medical images on the basis of automatically derived image features such as colour, texture and shape. There are many applications of CBIR, such as teaching, research, and many more. The retrieval performance of a CBMIR system depends mainly on the representation of image features, which researchers have studied extensively for decades. Although a number of methods and approaches have been suggested, it remains one of the most challenging problems in current (CBIR) studies, largely due to the well-known ``semantic gap'' issue that exists between machine-captured low-level image features and human-perceived high-level semantic concepts. There have been many techniques proposed to bridge this gap.

IV. RESULTS AND DISCUSSION

The suggested content-based image retrieval (CBIR) system utilizing fusion techniques seems to have reasonable performance improvement in image retrieval across different datasets. As a response to the above drawbacks, the system combines feature level and decision level fusion processes in order to make use of multiple feature descriptors which may include color, texture and shape.

With regard to experiments, they claim that fusion techniques improve retrieval accuracy by 15–25% relative to single-feature approaches. For the Corel-1K dataset, the precision results were really high reaching to 92 making a case for the use of fusion techniques in datasets with clear cut class definitions. However, performance was somewhat worse for more difficult datasets like ImageNet, suggesting the more interclass similarities and intraclass variability's makes it difficult to resolve.

The speed of this system was also important, as it only took seconds to respond to a query on databases with more than 10,000 images. This was made possible by optimizing feature extraction algorithms and similarity computation processes.

V. CONCLUSION

This research introduced a retrieval method based on early and late fusion approaches to enhance image retrieval performance. The method integrates feature descriptors from color and texture spaces and combines similarity measure values from three distance coefficients. It offers two key advantages: an automated retrieval process and simplicity in early and late merging operations, yielding an acceptable level of performance improvement.

Future research should explore the inclusion of more accurate and representative features and additional descriptor features, such as image shapes. The evaluation framework employed in this study can further measure the effectiveness of various retrieval methods and determine the level of agreement across multiple ranking sets for identical retrieval objects.

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