JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Content based Image Retrieval Using MATLAB

[1]B.Meenaiah, [2]D Anusha, [3]L Alekhya, [4]M.Raveena, [5]I Thrushitha

[1]Assistant Professor, [2,3,4,5]UG Student
[12,3,4,5]Department of Electronics and Communication Engineering
[1,2,3,4,5]Vignan Institute of Technology and Science, Deshmukhi, Telangana, India.

Abstract : This work aims in retrieving the similar images from the database based on automatically derived features of the image such as colour, texture and shape. Our findings are based on the research and literature and also on the discussions with the researchers in that particular relevant field. The need of finding desired similar images to an image is shared by many professional fields, such as design engineers, art historians and journalists. This System can also be used as an image search engine. As the requirements of image users can be varied according to them, the useful characterization of an image queries is divided into three levels of abstraction. The first level is of primitive features such as colour and shape. The second level is of logical features such as identity of objects and the last level is of abstract attributes such as the significance of the scenes that are in the query image.

IndexTerms **– Image, CBIR, GUI, MATLAB.**

I. INTRODUCTION

As the popularity of embedded camera devices and internet technology is increasing, a noticeable growth in web sharing, file sharing and photo browsing has been increasing from the past few decades. Hence, we came across that the number of applications were emerging based on image search. Generally, images are searched with the text, this is not so efficient in giving the exact results that a user is expecting from a search engine. As it deals with only titles and tags of the images that are present in the multimedia of the metadata information surrounding on the web. This is so inefficient and inconsistent as compares to the image search. so, we gained attention towards content-based image retrieval system (CBIR) which has a great advancing strategies in the technology from few years. Content-based image retrieval (CBIR) is a technique used in vision of computers and image processing to search for similar images based on the content present in an image. Instead on depending upon text or metadata, this system analyses the features of the image such as colour, texture, shape and spatial relationships for performing image retrieval. In CBIR, you will be uploading an image as a query image, then this system will retrieve the similar images from a database that are similar to the query image features. This can be done by extracting the relevant features from the query image and comparing them to database images to find similarity comparison. CBIR has many applications in different fields such as image databases, medical imaging, Surveillance Systems, Industrial automation, Artificial Intelligence, art collections and more. The goal of this system is to enable the efficient and effective retrieval of images based on their similarity of features. This approach of retrieving images in especially useful when searching for images that cannot be expressed in text annotations and textual descriptions. This aims to find images that are similar in features and visually similar to uploaded query image.

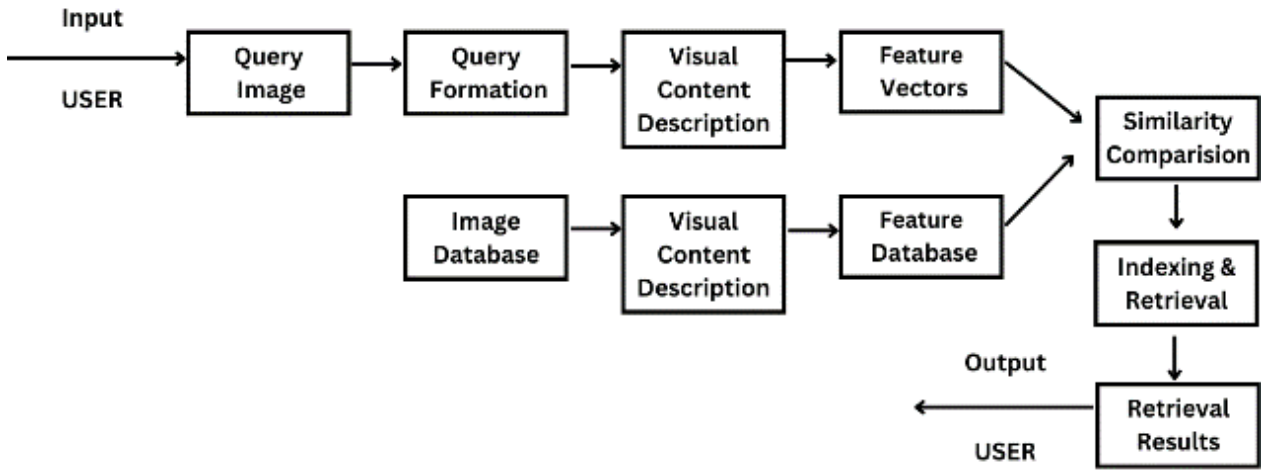
II. LITERATURE SURVEY

The importance of capturing the images is started in pre-roman times as they used to draw the moments in Hand drawn paintings, sculptures, paints on the walls of caves etc. and they used to draw the maps in a piece of paper to navigate the people from one place to another place. our ancestors from twentieth century invented first generation cameras to capture the moments and understood the importance of images in the all the situations of human life. Image capturing is very important for the people now-a-days as to engage and cherish them for the rest of their life. Images are very important in different fields such as medicine, journalism, advertising, design, entertainment and education.

Photography and television technologies have played a major role in serving the capture and communication of image data. But the exact revolution took place with invention of computers with its wide range of functionalities like digital image capture, image processing, image storage, image transmission. Computers involvement in imaging is from 1965 with Ivan Sutherland's project named Sketchpad project which demonstrated the feasibility of manipulation and storage of images, computerized creation etc. Though the hardware is costly at the time but made affordable after the mid of 1980.This made affordable because of video games manufacture and then the computer imaging went into areas depending more on images such as communication, engineering, architecture, medicine and fashion. Photograph libraries, art galleries and museums, too, began to use the images in electronic form and set their collections in the digital form. They found out many advantages in digitizing their images. Creation of World wide web (WWW) in 1990s that can be accessible to the users from anywhere in the planet made many advantages in digital imaging and had access to the variety of media provided a massive advantage to the exploitation of digital images. The

number of images available on the web was estimated recently as 750 billion images and this can be considered as an incredible number.

III. BLOCK DIAGRAM



Query Image: The query image is the image that a user provides as input to the system in order to find visually similar images from the database.

Query Formation: Query formation in Content-Based Image Retrieval (CBIR) involves the creation of a representative description of the visual content in an image to initiate the search process. This typically begins with the user providing a query image, which undergoes preprocessing to enhance its quality and consistency. Subsequently, relevant features are extracted from the query image, such as colour histograms, texture patterns, or shape descriptors, depending on the chosen feature representation. These features are then organized into a suitable format, often a feature vector, capturing the distinctive characteristics of the image. The formation of the query involves translating the visual content into a mathematical representation that can be compared with features extracted from images in the database.

Visual content Description: Visual content description is a process of extracting meaningful information and features from images or videos in order to represent their visual content. Visual content description in the context of Content-Based Image Retrieval (CBIR) involves the extraction and representation of key features that characterize the visual elements within an image. This process aims to create a meaningful and concise numerical representation of the image's content. Common low-level features include colour histograms, texture patterns, and edge information, while high-level features may encompass object recognition, shape descriptors, or spatial relationships. The choice of features depends on the specific requirements of the CBIR system and the nature of the images in the database.

Feature Vectors: A feature vector is a numerical representation of the features extracted from an object, image, or data point. It's a compact way to encode relevant information about the object's characteristics, making it suitable for various computational tasks, including machine learning, data analysis, and content-based retrieval. Feature vectors play a pivotal role in representing the visual content of images in Content-Based Image Retrieval (CBIR) systems. A feature vector is a numerical representation that encapsulates the distinctive characteristics extracted from an image through various feature extraction techniques, such as colour histograms, texture patterns, or shape descriptors.

Image Database: An image database serves as the foundation for content-based image retrieval (CBIR) systems, facilitating the organization and efficient retrieval of images based on their visual content. An image database is a structured collection of digital images stored for efficient retrieval and management in various applications, including Content-Based Image Retrieval (CBIR) systems. It serves as the repository of reference images from which users can search for or retrieve images based on their visual content. The images in the database can span diverse categories, encompassing a wide range of subjects, scenes, and characteristics.

Feature Database: A feature database is a repository that stores the extracted features from a set of images, forming a structured collection of numerical representations that capture the distinctive visual characteristics of each image. This database is integral to Content-Based Image Retrieval (CBIR) systems, as it enables efficient comparison and retrieval based on visual content similarity. The features stored in the database can include color histograms, texture patterns, shape descriptors, or other relevant information, depending on the chosen feature extraction techniques.

Similarity Comparison: Similarity comparison in Content-Based Image Retrieval (CBIR) involves the quantitative assessment of visual content resemblance between a query image and images stored in a database. The process typically employs various similarity measures, such as Euclidean distance, cosine similarity, or correlation coefficients, depending on the chosen feature representation. These measures quantify the difference or similarity between the feature vectors extracted from the query image and those stored in the database. The goal is to identify and rank images in the database based on their similarity to the query image.

Indexing & Retrieval: Indexing and retrieval are crucial components of Content-Based Image Retrieval (CBIR) systems, contributing to the efficient organization and rapid access of images based on their visual content. Indexing involves the creation of an organized structure, often utilizing feature vectors or other descriptors, to facilitate quick and systematic retrieval. This process may include methods such as clustering, hierarchical indexing, or content-based indexing, aiming to group similar images together for faster searching. Retrieval, on the other hand, is the actual process of obtaining relevant images from the organized

database in response to a user's query. The chosen similarity measure is applied to compare the features of the query image with those stored in the indexed database.

Retrieval Results: Retrieval results in Content-Based Image Retrieval (CBIR) systems represent the output generated by the system in response to a user's query. These results consist of a ranked list of images from the database, ordered based on their similarity to the query image. The effectiveness of the retrieval results hinges on the accuracy of the feature extraction, representation, and similarity comparison processes. Ideally, images at the top of the ranked list closely match the visual content of the query, while those lower down exhibit decreasing similarity. The user is presented with these results through the system's interface, allowing them to review and select images that align with their requirements.

Methods Used :

Colour Histogram: The user will input an image for the program to retrieve similar images to the input from a local database of photos. The representation of the user input will be performed according to the colour histogram feature where the HSV space is chosen. Each H (Hue), S (Saturation) and V (Value) component is uniformly quantized into 8, 2 and 2 bins with resulting dimensions of 32.

Colour Auto-Correlogram: Colour Auto- correlogram is a feature descriptor used in Content-Based Image Retrieval (CBIR) systems to capture spatial dependencies of colour occurrences in an image. It was introduced to address some of the limitations of traditional colour histograms by incorporating information about the spatial arrangement of colours. The Colour Auto-correlogram quantifies the probability of finding a pair of pixels with the same colour at a certain distance within an image.

Colour Moments: Colour moments are statistical measures that capture different aspects of the colour distribution in an image. They provide a concise representation of the colour content by summarizing the distribution of colour values in terms of central tendencies and spread. The three primary colour moments are the mean, variance, and skewness.

Gabor Wavelet: Gabor Wavelets play a significant role in image processing, offering a powerful tool for various tasks, including texture analysis, feature extraction, edge detection, and image representation.

Wavelet Moments: Wavelet moments are a set of features derived from wavelet transform coefficients that are commonly used in Content-Based Image Retrieval (CBIR). These moments capture important characteristics of an image and can be used to represent and compare images in a database. Here, I'll provide a brief overview of wavelet moments and how they can be used in CBIR using MATLAB.

Retrieving similar images using Euclidean Distance: Retrieving similar images using Euclidean distance involves a straightforward yet effective approach to content-based image retrieval (CBIR). In this method, images are represented as feature vectors, and the similarity between images is computed based on the Euclidean distance between their respective feature vectors. Each image in the database is assigned a feature vector that encapsulates relevant characteristics, which can be derived from various feature extraction methods, such as colour histograms, texture descriptors, or deep learning features.

Graphical User Interface: Graphical User Interface (GUI) development in MATLAB provides a user-friendly way to interact with your code and data, enabling the creation of applications with buttons, sliders, plots, and other visual elements. MATLAB's GUI development is facilitated by the GUIDE (GUI Development Environment) tool, which allows users to design interfaces through an interactive and visual process.

IV. Coding and Outputs

In this work, a CBIR algorithm will be developed using MATLAB as a platform where the program's input will be a query image taken from the user to retrieve similar to the given image as an output. The dataset where the output images will be retrieved is a local database with a number of 1000 photos in a folder with a dataset of 1000 in it. As previously discussed, the similarity measurement criteria can widely vary, in the work at hand however, the features that will be extracted from the image will be colour based where the similarity will be histogram similarity. The developed code will be discussed in details along with the testing and evaluation of the results along with the comparison of the work at hand with competing systems and approaches.

The program is made with a GUI (graphical user interface) to be clear and easy to use. The image dataset which the search is made on are stored in the folder "images", the main GUI is coded in the two files "CBIR.fig" and "CBIR.m" but the process of features extraction is made by the code "Extract_features.m". First the query image is loaded at this point all the previously mentioned features are extracted from the image then it is shown in the main GUI platform under title "Loaded image".

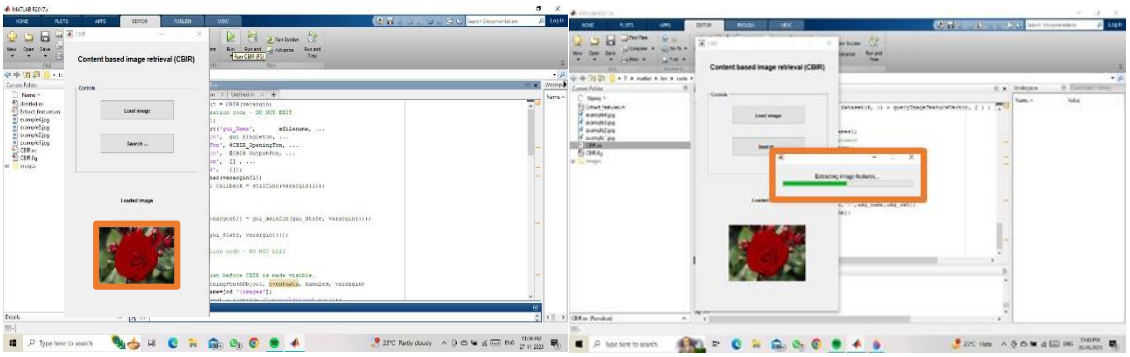


Fig.1. Loaded Image

Then the extracted features are compared to the already saved and processed database where the distance between the query image and all the different images in the dataset is calculated. Finally, the nearest twenty images to the query image are shown in the GUI named “Search results” as shown in the next image made to test algorithm.

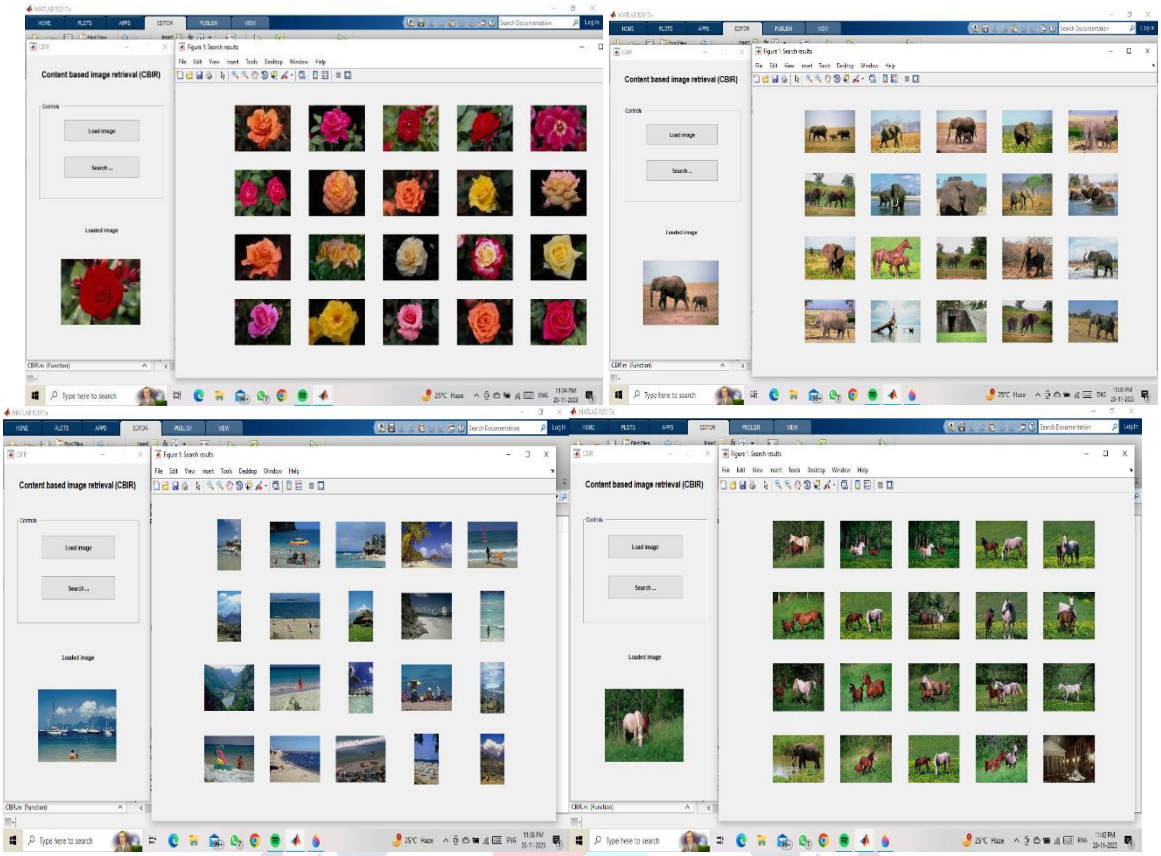


Fig.2. Search Results

V. CONCLUSION

In conclusion, the MATLAB code implements a Content-Based Image Retrieval (CBIR) system, integrating a graphical user interface for user-friendly interaction. The CBIR system focuses on extracting diverse image features from a query image, including colour histograms, auto-correlograms, colour moments, Gabor wavelets, and wavelet moments. These features collectively serve as a unique signature, capturing both low-level and semantic information from the images. The search mechanism utilizes Euclidean distances to measure the similarity between the query image and images within the dataset. The top-ranking images, determined by the smallest Euclidean distances, are then displayed as search results. The system provides a clear visual representation of the most similar images, aiding users in retrieving content-related matches. The code demonstrates a thoughtful approach to feature extraction, encompassing both low-level colour information and higher-level semantic content through advanced techniques like Gabor wavelets and wavelet moments. The inclusion of a graphical user interface enhances the accessibility of the CBIR system, making it user-friendly. The presented MATLAB code for Content- Based Image Retrieval (CBIR) offers a solid foundation with potential avenues for future improvement and expansion. One notable aspect for future enhancement lies in the integration of more advanced feature extraction techniques and deep learning models. Exploring convolutional neural networks (CNNs) for feature learning could enhance the system's ability to discern complex patterns and relationships within images, potentially improving retrieval accuracy. Additionally, considering the scalability of the system by incorporating cloud-based solutions or parallel processing techniques could be explored. This would enable the CBIR system to handle larger datasets efficiently, making it more robust and applicable to real-world scenarios with extensive image collections. Overall, the future scope of the presented CBIR code involves a convergence of advancements in feature extraction, machine learning, and scalability, with a keen focus on improving accuracy, efficiency, and adaptability to diverse image datasets and application domains.

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