Secure Content Based Image Retrieval System Using CNN and VGG-16

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ABSTRACT: Secure image retrieval has attracted considerable interests recently due to users security concerns, such as data encryption, feature extraction, and image similarity scoring. CBIR system utilizes the outline of the content present in the image to spot and retrieve related images. A database is a collection of information that is organized for easy storage, retrieval and update. This information is represented in many forms like text, table, image, chart and graph etc. here we concentrate on information that is stored in the form of images. A CBIR system is able to query an image over a database of images and return a set of results that most closely matches the queried image. In this paper, I propose and implement a secure CBIR framework that performs image retrieval on the database. A pre-trained deep CNN model, i.e., VGG-16, is used to extract the deep features of an image. I implemented this CBIR system using python language and flask framework and torch library for better accuracy and efficiency. The experimental results show that the framework is efficient and accurate.

KEYWORDS: Content based image retrieval (CBIR), Convolution Neural Network model (CNN), VGG-16

1. INTRODUCTION

Content-based image retrieval technique uses visual contents to search images from large scale image databases based on user's interests. It becomes an active and fast advancing research area. Image content may include both visual and semantic content. Content-Based Image Retrieval (CBIR) is a technique for retrieving images on the basis of automatically-derived features such as colour, texture and shape. These techniques includes several areas such as image segmentation, image feature extraction, representation, mapping of features to semantics, storage and indexing ,image similarity-distance measurement and retrieval which makes CBIR system development as a challenging task. Several companies are maintaining large image databases, where the requirement is to have a technique that can search and retrieve images in a manner that is both time efficient and accurate. Content-based image retrieval, also known as query by image content and content-based visual information retrieval is the application of computer vision to the image retrieval problem, that is, the problem of searching for digital image in large databases. Content-based means that search makes use of the content based image retrieval system (CBIR) is a piece of software that implements CBIR. In CBIR each image that is stored in the database has its features extracted and compared to the features of the query image. There are three important feature components for content based image retrieval. The most common are color, texture and shape or combinations of these. These features are combined to achieve higher retrieval efficiency. Here, I implement an secure CBIR framework that performs image retrieval on the image database. A pre-trained deep Convolutional Neural Network model, i.e., VGG-16, is used to understand the deep features of an image. The experimental results show that the framework is efficient and accurate.

2. LITERATURE SURVEY

The main objective of this paper is to develop secure CBIR system using deep CNN model i.e., VGG-16. The main steps for this CBIR system is feature extraction, similarity metric, data encryption. Choras et al proposed an integrated color, texture and shape feature extraction method in which Gabor filtration is used for determining the number of regions of interest (ROIs). They calculated texture and color features from the ROIs based on threshold Gabor features and histograms, color moments in YUV space, and shape features based on Zernike moments. The features presented proved to be efficient in determining similarity between images. Singh and Hemachandran presented the content based image retrieval using features like texture and color, called Wavelet Based Color Histogram Image Retrieval (WBCHIR). The texture and color features are extracted through wavelet transformation and color histogram and the combination of these features is robust to scaling and translation of objects in an image. He also demonstrated a promising and faster retrieval method on a WANG image database containing 1000 general-purpose color images.

Pinjarkar et al. discussed various methodologies used in the research area of Content Based Image Retrieval techniques using Relevance Feedback. To improve the retrieval performance of the CBIR the Relevance Feedback technique can be incorporated in CBIR system to obtain the higher values of the standard evaluation parameters used for evaluation of the CBIR system which may lead to better results of retrieval performance. He also discussed various relevance feedback techniques for Content Based Image Retrieval systems, the

various parameters used for experimental evaluation of the systems and the analysis of these techniques on the basis of their results. It provides an overview of the technical achievements in the research area of Relevance Feedback (RF) in Content-Based Image Retrieval (CBIR). It also covers the current state of art of the research in relevance feedback in CBIR, various relevance feedback techniques and issues in relevance feedback.

Dubey illustrated about an image mining methods which is dependent on the color Histogram, texture of that image. The query image is considered, then the COLOR Histogram and Texture is created and in accordance with this the resultant image is found. In this approach computing time for RGB color space not considered.

3. CBIR FRAMEWORK

I propose and implement a CBIR framework that shifts excessive computations onto the cloud servers, such as secure image re-encryption, deep feature extraction, and image similarity scoring. I use a pre-trained deep CNN model, i.e., VGG-16, to extract the deep features of an image and flask framework is used for better accuracy and also pytorch library is used for efficiency. The experimental results show that the framework is efficient and accurate.

CONVOLUTIONAL NEURAL NETWORK (CNN)

Convolutional Neural Network (CNN) is a deep artificial neural network, which has been proven very effective in areas such as image classification and objects recognition. A CNN is usually composed of linear layers each of which can be a convolutional (Conv) layer, or a fully-connected (FC) layer, and non-linear layers each of which applies a non-linear function, a activation function, that acts on each element of the input, or a pooling function that reduces the output size. Typical non-linear functions can be one of several types, the most common in the convolutional setting are MaxPool function and ReLU function. A CNN has several layers of non-linearity's, which allows extracting increasingly complex features of the input and can lead to a better ability to generalize. The Visual Geometry Group network (VGG-16) can serve as a high accurate feature extractor. Its architecture is shown in Figure.1. The input image to the VGG-16 network is of fixed size, i.e., 3224224. It is passed through a stack of various convolutional layers of different receptive fields.

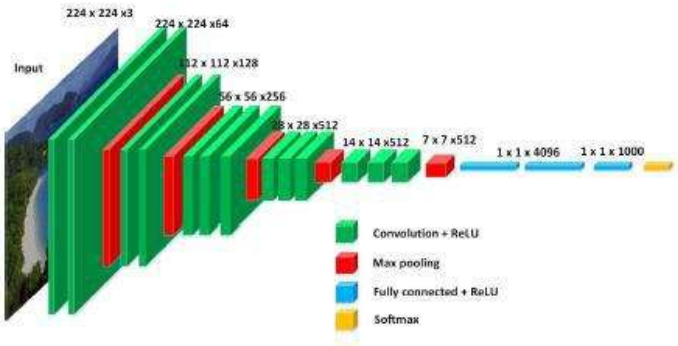

FIGURE 1. VGG-16 network architecture for feature extraction.

The stride rate for convolutional layers and pooling layers remains the same throughout the VGG-16 network which is3x3 with stride 1 in convolutional layer and 2x2 with stride2 in pooling layer. The worst two convolutional layers have 64 and 128 filters, respectively. The rest of the convolutional layers include 256, 512 and 512 filters, respectively. Border pixels are padded before each convolutional operation, which can preserve the features maps size same to the input. TheVGG-16 is ended with three fully connected layers. The first two FC layers consist of 4096 neurons while the final FC layer compresses the features to 1000 dimensions

4. METHODOLOGY

The existing methodology consists of following general steps.

1. Pre-processing

The image data is highly non-trivial. Reprocessing phase is applied to remove noise from the image. And it also consists of image segmentation. By applying noise removal filter, thinning, cleaning noise can be removed. Pre-processing phase also include object identification. Pre-processing determines the effectiveness of image mining application.

2. Feature Extraction.

The features extracted based on their visual content which are shape, color, and texture. Feature extraction is a means of extracting compact but semantically valuable information from images. This information is used as a signature for the image. Similar images should have similar signatures.

3. Feature selection.

Feature selection helps to reduce the feature space that improves the prediction accuracy.

4. Classification.

Classification process involves two phases:

Training and testing phase.

The Fig1 shows the block diagram of CBIR system. The retrieval process starts when the user enters a query image in the system. The query image features are extracted by using feature extraction method i.e., VGG-16. The visual contents of the database images are extracted by the same feature extraction method i.e., VGG-16 and foam a image features database. The similarity methods are used to calculate the distance between the query image features and target images in the image features database, and then the images are retrieved according to their similarity values and displayed as a output in CBIR system.

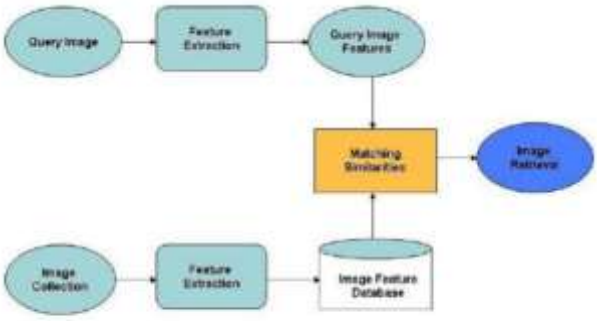

Fig.1 Content Based Image Retrieval Systems

A. Shape method

Shape is one of the important features and contains the most attractive visual information for human perception .We use the term shape to refer to the information that can be deduced directly from images and that cannot be represented by color or texture; as such, shape defines a complementary space to color and texture. Shape representations techniques used in similarity retrieval are generally characterized as being region based and boundary based.

B. Color method

The colour feature has widely been used in CBIR systems, because of its easy and fast computation. Color is one of the visual attributes that can provide more information about the visual content of an image and the most widely used feature in CBIR. This is a compact representation of the color feature to characterize a color image. Color is one of the important features of an image, which depicts much of the information from the image. RGB color model do not correspond to the human way of perceiving the colors. And also RGB space does not separate the luminance component from the chrominance ones. Therefore, chi-squared distance is used for color histogram.

C. Texture method

Texture is one of the most important defining features of an image. In image classification texture provides important information as in many images of real world. Texture is another important attribute of an image and it refers to innate surface properties of an object and

their relationship to the surrounding environment. For texture analysis we use a least square error technique for gabor filter. This is a simple and effective method for representing texture.

D. Similarity measure

The Similarity functions seek calculates the content difference between two images based on their features. One of the images is given as search parameter and another is stored in the database and had their features previously extracted. A measurement of how close a vector to another vector is called similarity measurement .The query image features are used to retrieve the similar images from the image database. Instead of directly comparing two images, similarity of the query image features is measured with the features of each image in the database. Computing the distance between the feature vectors is the measure of similarity between two images. The retrieval systems return the first images, whose distance from the query image is minimum. We used orthogonal projection of one feature vector onto another for VGG16 method to compare similarity between features.

5. IMPLEMENTATION AND RESULTS

Steps followed:

step1: Feature extraction

Feature extraction is a means of extracting compact but semantically valuable information from images. This information is used as a signature for the image. Similar images should have similar signatures. Deep methods VGG16 is a convolutional neural network model pre-trained on ImageNet dataset. VGG is a convolutional neural network model for image recognition proposed by the Visual Geometry Group in the University of Oxford, where VGG16 refers to a VGG model with 16 weight layers, and VGG19 refers to VGG model with 19 weight layers. Figure illustrates the architecture of VGG16: the input layer takes an image in the size of (224x224x3), and the output layer is a soft max prediction on 1000 classes. From the input layer to last max pooling layer (labeled by 7 x 7 x 512) is regarded as the feature extraction part of the model, while the rest of the network is regarded as the classification part of the model.

Step 2: Indexing dataset
Now apply an image descriptor to each image in your dataset, extract features from these images, and write the features to storage (ex. CSV file, RDBMS, Redis, etc.) so that they can be later compared for similarity.

Step 3: Define similarity metric Depending upon the dataset and types of features extracted, define a method (ex. Euclidean distance, Cosine distance, and chi-squared distance) to compare features for similarity. I used chi-squared distance for color histogram and HOG methods, least square error technique for gabor filter method and orthogonal projection of one feature vector onto another for VGG16 method to compare similarity between features.
Step 4: Retrieve image

The image should be retrieved based on the similarity metric, when we entered a query image based on the similarities the resultant images will be displayed.

Results:

The smart CBIR system is written in python language in the anaconda IDE. The python version 3.7 is used and anaconda IDE is used for development, and the flask framework is used. Flask is a lightweight WSGI web application framework. It is designed to make getting started quick and easy, with the ability to scale up to complex applications. It began as a simple wrapper around Werkzeug and jinja and it is one of the most popular python web application frameworks. PyTorch is an open source machine learning library used for developing and training neural network based deep learning models. PyTorch can be used with Python as well as C++. Naturally, the Python interface is more polished. Pytorch (backed by biggies like facebook, Microsoft, Sales Force, Uber) is immensely popular in research labs. Not yet on many production servers that are ruled by frame works like TensorFlow (Backed by Google) Pytorch is picking up fast.When we execute the application program then we will redirected to this page show in fig: 1 this is the main page and there it asked for us to choose a query image for the database.

Figure 1: CBIR page

After selected the query image from the database as shown in fig: 2 we have chick on ok button shown below.

Figure 2: Selected image from the database

After clicking on ok, we have to upload the query image and after uploading we will get a notification “uploaded successful” as shown in fig: 3

Figure 3: Uploaded image

And at last we will get the images which are similar to the query image according from the database.

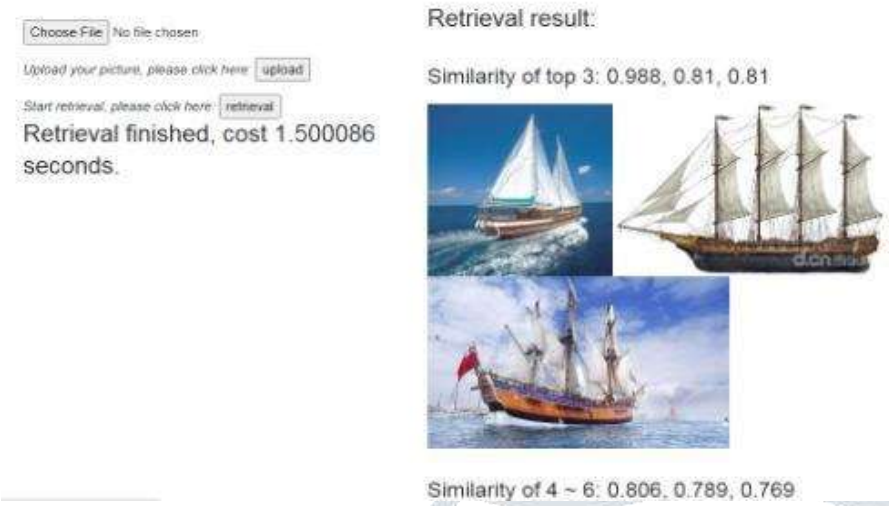

Figure 4: Retrieved images

6. CONCLUSION

This paper elucidates different proposed methods and techniques used by the researchers. It propagates the significance of content based image retrieval systems. The ultimate aim of CBIR systems is to extract the features like shape, colour and texture of the image from the database and compare it with the query image in order to retrieve the desired image. More methods and techniques are in progress to make content based image retrieval system more effective and efficient. This overview focuses on content based image retrieval implementations, usability and challenges. It also delivers conceptual overview of methodology. We proposed a secure CBIR framework that uses VGG-16 as an accurate deep feature extractor. We further proposed a secure image similarity scoring protocol, which enables the cloud servers to compare two images without knowing any information about their deep features**.**

7. FUTURE SCOPE

We implemented a real number computation mechanism and a divide-and-conquer CNN evaluation protocol to enable our framework to securely and efficiently evaluate deep CNN with a large number of inputs. We further proposed a secure image similarity scoring protocol, which enables the cloud servers to compare two images without knowing any information about their deep features.

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