Similarity Image Retrieval using Enhanced Color Histogram Based on Support Vector Machine.

Emile Karamutsa¹, Dr. Cheruiyot W.K², Dr. Anthony luvanda³

Abstract- In this paper, enhanced color histogram method is presented basing on supporting vector machine technique, in similarity image retrieval system. Enhanced color histogram set to deal with acute precision to retrieve similar images by using color histogram. A SVM classifier can be learned from training data of relevant images and irrelevant images marked by users. By using the classifier, the system can retrieve more images relevant to the query in the database efficiently to get desired images. The research focus is to get relevant images more than irrelevant ones. The enhanced color histogram alone could not provide better results so it needs other techniques to classify the calculated features corresponding to one real object that has the same or similar pixels value by ranking similar images from the highest score to the lowest score which is the precision of how the image is recognized by the learning algorithm. The experiments were carried out on a multimedia database of 222 images classified into 3 categories. It demonstrates the efficiency (the computation time compared to the search on entire collection) and effectiveness with the improvement of 25% - 35% in precision and recall of the method compared to the previous.

Keywords: similarity Image retrieval; support vector machine;; color histogram; precision and recall.

1. Introduction

The concept of similarity has been widely investigated throughout the last century, both in the field of psychology and in that of computer science, attempting to define a theory consistent with the huge amount of experimental data. An important point, discovered by computer scientists only in recent times Simone S. and Ramesh J. (1998) is the discrepancy between the concepts of similarity in psychology and in computer science. In computer science, usually, the similarity has the target of recognizing an object under conditions of uncertainty. There is an object and a model of the same object: The system has to assess if the actual appearance of the object, different from the appearance of the model due to noise, distortion, etc. is consistent with the model itself. Computer scientists, thus, have to define the class of possible transformations that an object can undergo. The human concept of similarity is completely different: Human mind has to assess the similarity between different objects. Thus, there is no way to define a number of deformations to transform an object into another one. It is, therefore, possible, for computer scientists, to assess the similarity between two rotated images of a cube, since it is easy to model all the possible rotations of a cube in the space, but the task of assessing the similarity between a cube and a tetrahedron is a difficult one. And an even
more difficult task is that of assessing if the image of a cube is more similar to that of a tetrahedron or to that of a sphere. The concept of similarity for our scenario is that of psychologists, since we want our system to model the behavior of human mind in comparing perceptual stimuli. Therefore, in the paper, we will review enhanced color histogram basing on SVM for similarity image retrieval. The goal of researcher is to obtain a concept of similarity sufficiently “close” to that of human mind, but also useful for the purposes of searching in a database. Cheruiyot, W.et all (2011) discussed about the similarity between the query and retrieved image as it is measured by different retrieval strategies that are based on the more frequent terms found in both the image and the query. Avneet, K., Vijay, K. B., Navkirat, K. (2013). Argue that, there are so many techniques to extract relevant images on the color basis. Every image in the database is processed to determine its color histogram which depicts the quantity of pixels of each color contained by the image. Then these color histograms are saved in the record. During the process, the end user can also give the desired percentage of each color or load an example image as a query whose color histogram is computed. Then, the similarity measure searches those images from database whose color histograms resembles strongly with the query image. Swain and Ballard (1991) was first introduced a matching method called histogram intersection which is most commonly used. The combination of histogram intersection with several aspects of spatial matching, and region-based color query, is also very popular. The results generated from some of these methods look quite imposing. The goal of this paper is to get basic practical experience with image classification for better use of enhanced color histogram to retrieve similar images. It includes: (i) training a visual classifier for three different image classes \( (\text{aeroplanes}, \text{motorbikes}, \text{and people}) \); (ii) assessing the performance of the enhanced color histogram by computing average precision-recall of similar images basing on linear supporting vector machine (SMV). Our algorithm improves the performance of the image retrieval based on enhanced color histogram. The main idea is to use the linear support vector machines, a popular data mining algorithm. And get briefly the idea behind the linear SVM through matlab codes. The Figure1 shows the framework of our proposed SIR system.

![Figure 1: the SIR system framework](image)

2. Similar Image Retrieval Using Enhanced Color Histogram

According to Venn den (2005) color histogram is a method for describing the color content of an image, it counts the number of occurrences
of each color in an image [321]. The color histogram of an image is rotation, translation, and scale-invariant; therefore, it is very suitable for color-based CBIR: content-based image retrieval using solely global color features of images. However, the main drawback of using the color histogram for CBIR is that it only uses color information, texture and shape-properties are not taken into account. This may lead to unexpected errors; so this paper introduce enhanced color histogram based on support vector machine to reduces the errors caused by color histogram, the paper takes images retrieved by color histogram and rank them according to how they are recognised by the learning algorithm, its analyses also the results by giving the average precision of the retrieved images. The following figures are the process of how color histogram changed to enhanced color histogram.

**Figure2: color histogram of original images.**

**Figure3: color histogram enhanced**

**Figure 4: retrieved image results using color histogram results**

It is observed that enhanced color histogram has its main task to improve the results of the processed image which forms a set of possible image query solutions might not satisfy the retrieval needs of a user. The retrieval process, for a given query should finish at a point when the user is satisfied with the retrieved images [36]. Our Final goal is to apply the SVM to further enhance color histogram in order to obtain a better precision of similarity image retrieval system.


The Support Vector Machine (SVM) is a state-of-the-art classification method introduced in 1992 by Boser, Guyon, and Vapnik. In machine learning, support vector machines
(SVMs, also support vector networks) are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification and regression analysis. Given a set of training examples, each marked for belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples into one category or the other, making it a non-probabilistic binary linear classifier. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall on. SVM (Support Vector Machine) are a useful technique for data classification. An SVM classifies data by finding the best hyperplane that separates all data points of one class from those of the other class. The support vector machine learning algorithm is applied to produce the classification parameters according to calculated features. Neighboring pixels corresponding to one real object have the same or similar brightness value. If a distorted pixel can be picked out from the image, it can be restored as an average value of neighboring pixels. Similarity learning is an area of supervised machine learning in artificial intelligence. It is closely related to regression and classification, but the goal is to learn from examples a similarity function that measures how similar or related two objects are. It has applications in ranking, in recommendation systems and face verification.

In image classification, an image is classified according to its visual content. For example, does it contain an airplane or not. An important application is similarity image retrieval - searching through an image dataset to obtain (or retrieve) those images with particular visual content.

3. Similarity and metric learning

The learning machine is given pairs of examples that are considered similar and pairs of less similar objects. It then needs to learn a similarity function (or a distance metric function) that can predict if new objects are similar. It is sometimes used in Recommendation systems. To further explain the difference between color histogram and enhanced color histogram systems in responding to different images, we show Figures 4.3 and 4.4 the top 36 retrieval results of the two systems responding to different two query images from the Elephants class and Flowers class in the database.

4. Performance measures

The measures of performance used in image retrieval borrow from the field of (document) information retrieval and are based on two primary figures of merit: Precision and recall. Precision is the number of relevant documents retrieved by the system divided by the total number of documents retrieved (i.e, true positives plus false alarms) [35]. Recall is the number of relevant documents retrieved by the system divided by the total number of relevant documents in the database (which should, therefore, have been retrieved).
Precision can be interpreted as a measure of exactness, whereas recall provides a measure of completeness. A perfect precision score of 1.0 means that every retrieved documents (or images in our case) was relevant but does not provide any insight as to whether all relevant documents or images were retrieved. A perfect recall score of 1.0 means that all relevant images were retrieved, but says nothing about how many irrelevant images might have also been retrieved.

Figure 5. Precision and Recall
A more compact representation of the precision and recall properties of a system consists in combining those two values into a single figure of merit, such as the $F$ measure (also known as $F1$ measure) that computes the weighted harmonic mean of precision and recall.

5. Results and Discussion
This SIR system is implemented in Matlab and SQL is used as a backend tool for database creation and management. The similarity image retrieval by a given query image involves searching the database for similar images. Enhanced color histogram is suitable and effective method which is widely used in image retrieval area. The retrieval results are a list of motorbike, airplane and persons images ranked by their similarities measure with the query image. The images in the database are ranked according to their classes to the query image in numbering orders, and then the ranked images are retrieved. The computed similarity query image is ranked and retrieve images according to closest similar; in addition, if the similar image is less than a certain threshold set, the corresponding original images is close or match the query image. Precision $P$ is defined as the ratio of the number of retrieved relevant images $r$ to the total number of retrieved images $n$, i.e., $P = \frac{r}{n}$. Precision measures the accuracy of the retrieval.

$$Precision = \frac{\text{No. of relevant image retrieved}}{\text{Total No. of image retrieved}} = \frac{r}{n}$$

Recall is defined by $R$ and is defined as the ratio of the number of retrieved relevant images $r$ to the total number $m$ of relevant images in the whole database, i.e., $R = \frac{r}{n}$. Recall measures the robustness of the retrieval.

$$Recall = \frac{\text{NO. of relevant image retrieved}}{\text{Total no. of relevant images retrieved}} = \frac{r}{n}$$

The databases of 222 images of different classes respectively are used to check the performance of the algorithm developed. Classification of different classes in the database and the number of similar images in each class is depicted in table 1.

Table 1: Classification for database of 222 images.

<table>
<thead>
<tr>
<th>Class</th>
<th>Persons</th>
<th>Motorbike</th>
<th>Airplane</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of images</td>
<td>74</td>
<td>76</td>
<td>72</td>
</tr>
</tbody>
</table>

The following figures indicate how the user of this query system can choose a query image.
that is in database to evaluate the results of the query system.

**Query1**: comparison of enhanced color histogram based on SVM with color histogram of person class

**Query 2**: comparison of enhanced color histogram based on SVM with color histogram of motorbike class

**Query 3**: comparison of enhanced color histogram based on SVM with color histogram of aeroplane class
From Figures of query#1, query#2 and query#3, we can notice that the Enhanced Color histogram gives good results for pictures that have distinct objects with color contrast from background and this is because the images give good results in the Browse query images, which is the first stage in the Enhanced color histogram system. In query#1, the query image has a distinct object of large area which is a person, and a background of less area; this makes working on image regions better than working on global features of the image. The objects in query#2 are not clear and have smaller area than the background; this makes global features more effective than features extraction from image regions as shown in the figure. Table 3 gives the retrieval precision of the color histogram and Enhanced color histogram systems, for top 37 retrieved images responding to three queries.

### Table 2: Precision of color histogram, and Enhanced color histogram for top 37 retrieved Results Responding to three queries.

<table>
<thead>
<tr>
<th>Method used</th>
<th>Efficiency achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Query#1</td>
<td>Query#2</td>
</tr>
<tr>
<td>Color histogram</td>
<td>71.04%</td>
</tr>
<tr>
<td>Enhanced color histogram</td>
<td>96.01%</td>
</tr>
</tbody>
</table>

The results in the table 2 ensure the difference between color histogram and Enhanced color histogram based on support vector machine for top 36 retrieved images responding to three selected queries. Enhanced color histogram is more effective for all queries than color histogram, and as can be noticed the Enhanced color histogram method gives better results in both queries.
6. Conclusion

Based on the results our algorithm improves the performance of the similarity image retrieval based on enhanced color histogram. The main idea of this paper is to use the linear support vector machines, a popular data mining algorithm together with enhanced color histogram to get acute precision of retrieved images. The results from three different queries show that using the technique has greatly influence the amount of performance improvement. So, we should try to use Enhanced color histogram based on support vector machine in similarity image retrieval to get a desired results of similar images.

7. References


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