EFFICIENT APPROACH FOR CONTENT BASED IMAGE RETRIEVAL USING MULTIPLE SVM IN YACBIR

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ABSTRACT

Due to the enormous increase in image database sizes, the need for an image search and indexing tool is crucial. Content-based image retrieval systems (CBIR) have become very popular for browsing, searching and retrieving images in different fields including web based searching, industry inspection, satellite images, medical diagnosis images, etc. The challenge, however, is in designing a system that returns a set of relevant images i.e. if the query image represents a horse then the first images returned from a large image dataset must return horse images as first responses. In this paper, we have combined YACBIR [7], a CBIR that relies on color, texture and points of interest and Multiple Support Vector Machines Ensemble to reduce the existing gap between high-level semantic and low-level descriptors and enhance the performance of retrieval by minimize the empirical classification error and maximize the geometric margin classifiers. The experimental results show that the method proposed reaches high recall and precision.

KEYWORDS

Content Based Image Retrieval, YACBIR, Feature extraction, Multiple Support Vector Machines, Classification

1. INTRODUCTION

With fast and exceptional growth in digital technology, a significant increase in the number of images produced by scientific, educational, medical, industrial, virtual museums, individual photograph collections and other applications raises several practical issues.

Content-based Image Retrieval (CBIR) system [1] [2] [3] [4] is the application of computer vision techniques which is used to extract similar images from an large image database. CBIR system is mainly used in various applications such as art collections, education and training, crime prevention, military field, architectural and engineering design, journalism and advertising, and web searches [5].

Simply stated, a CBIR system retrieves images corresponding to a query image by examining the image contents (low-level feature). Many image low-level features such as color, texture and shape are widely used [7]. The color aspect can be treated by techniques like averaging and histograms. The texture aspect can be achieved by using four descriptors: contrast, entropy, energy and inverse differential moment [8]. The shape aspect can be extracted by gradient or morphological operators [6] or by considering points of interest. [8].
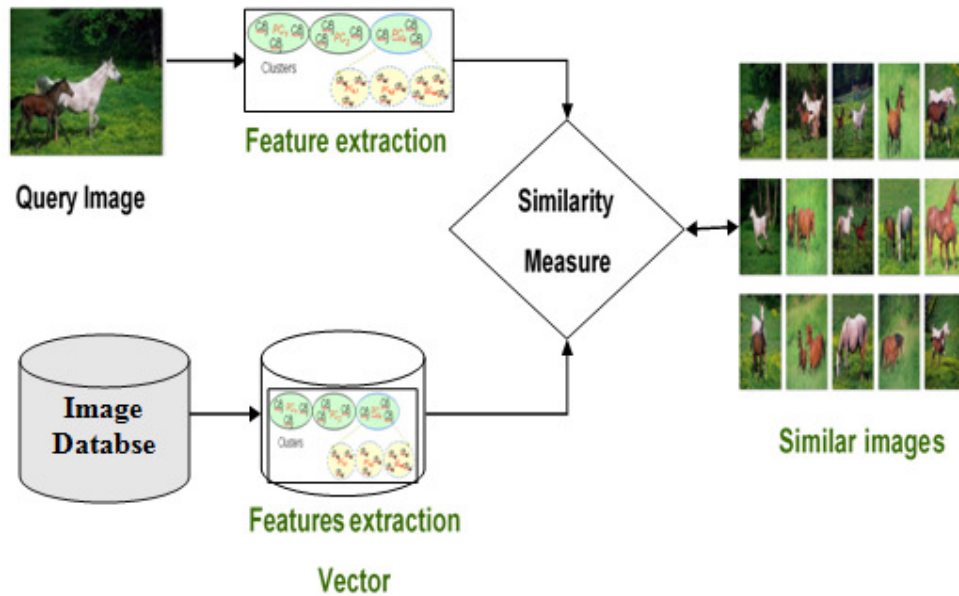
Figure 1: Content Based Image Retrieval Approach.

The main goal in CBIR system is searching the similar images from the database based on their content. To accomplish the retrieval task, CBIR system firstly computes and stores the feature vector for each image in the database. When the query image is introduced in the system, its feature vector will be extracted and compared to those of other images in the database. Then a series of similar images is returned to the user. Different similarity measures are used in the matching process [6].

This paper is organized as follows. We give in section 2 an overview of our proposed system. In section 3, concepts of SVM (Support Vector Machine) are reminded. Experimental results on sample datasets are given in section 4. Section 5 gives conclusions.

2. OVERVIEW OF PROPOSED SYSTEM

2.1. Method summary

Step 1: Feature extraction f (Color, Texture, and Point of interest).

Step 2: Sum of weighted color, texture and points of interest features.

Step 3: Query image feature classification by Multiple   Support Vector Machines (Find the class Label).

Step 4: Compute the distance between the Query image and   images in the dataset (Class Label).

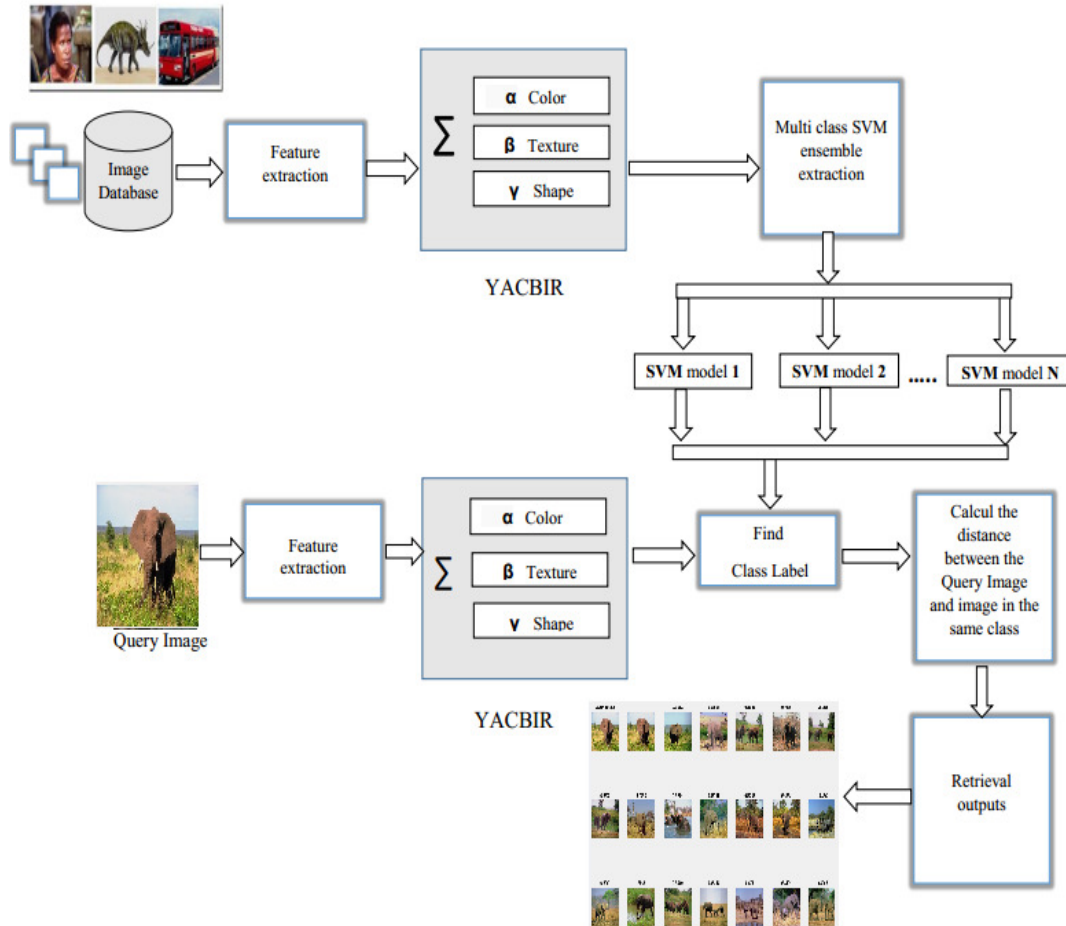**Step 5:** Output Retrieved images (Similar images).

Figure 2: Overview of the process

2.2. Feature extraction in YACBIR

Feature extraction is a common way to improve the performance of the visual features and improve the efficiency of the CBIR systems. The best subset of features is selected by a heuristic search algorithm to improve the precision of CBIR system. Three types of features are used for image indexing [7].

Color   - HSV
Texture -contrast, entropy, energy and inverse differential moment
Point of interest -Harris detector

The YACBIR system combines three characteristics of an image to compute a weighted similarity measure. The characteristics of the image are the color, texture and points of interest. Color and texture characteristics used are global while points of interest are local shape characteristics. The similarity measure used in YACBIR is a sum of weighted color, texture and points of interest (shape) similarity measures. This similarity measure is given by:

$$S = \alpha.Sc + \beta.St + \gamma.Ss \quad \text{with } (\alpha+\beta+\gamma) = 1$$

2.3. Support Vector Machines (SVM)

In machine learning, support vector machines (SVM) are supervised learning models with learning algorithms. Given a set of data where each data is marked as belonging to one of two categories, a SVM training algorithm constructs a model which classifies new data in one of these two classes. Though SVMs are fundamentally developed for such binary classification case, they are extendable for multi-class problems [9].

The SVM algorithm consists of two phases:

a. Training phase:

Input learning data for a SVM classifier can consist of distance to border vectors, binary images, Zernike moments, and more. Each input data is represented by vector $\mathbf{x}_i$ with label $y_i = \pm 1$, $1 \le i \le l$, l is the number of samples.

The decision boundary should classify all points correctly, thus

$$y_i\left(\mathbf{w^T}\mathbf{x}_i + b\right) \ge 1, \ \forall i \ .$$

The decision boundary can be found by solving the following constrained optimization problem:

$$Minimize \ \frac{1}{2}\left\|\mathbf{w}\right\|^2 \quad subject \, to \ y_i\left(\mathbf{w^T}\mathbf{x}_i + b\right) \ge 1 \ \forall i$$

The Lagrangian of this optimization problem is:

$$L = \frac{1}{2}\left\|\mathbf{w}\right\|^2 - \sum_i \alpha_i \left(y_i\left(\mathbf{w^T}\mathbf{x}_i + b\right) - 1 \right) \ \alpha_i \ge 0 \ \forall i \ \mathrm{T}$$

the optimization problem can be rewritten in terms of α_i by setting the derivative of the Lagrangian to zero:

$$Maximize \ W\left(\alpha\right) = \sum_i \alpha_i - \frac{1}{2}\sum_{i,\,j} \alpha_i \alpha_j y_i y_j \mathbf{x}_i^T \mathbf{x}_j$$

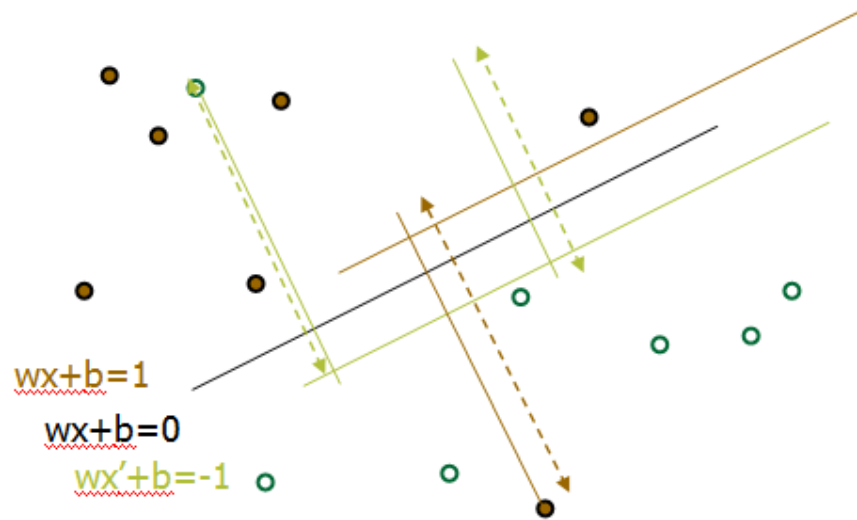$$subject \, to \ \alpha_i \ge 0, \ \sum_i \alpha_i y_i = 0 \ \forall i$$

Figure 3: Support Vector Machine (SVM).

This quadratic programming problem is solved when:

$$\alpha_i \left(y_i \left(\mathbf{w^T} \mathbf{x}_i + b \right) - 1 \right) = 0 \quad \forall i \; \mathbf{x}_i \text{ with } \alpha_i > 0$$

b. Testing phase:

The resulting classifier is applied to unlabelled images to decide whether they belong to the positive or the negative category. The label of x is simply obtained by computing:

$$\mathbf{w} = \sum_{j=1}^{s} \alpha_{t_j} y_{t_j} \mathbf{x}_{t_j} \quad \text{with } t_j \left(j = 1, \mathrm{K}, s \right) \text{ the indices of the } s \text{ support vectors. Classify } \mathbf{z}$$

as category 1 if the sum is positive, and category 2 otherwise.

3. EXPERIMENTAL RESULTS

The experiments in this section are performed on a workstation with an Intel Corei3 2.10 GHz CPU and 4 GB of RAM running Win 10.

We evaluate the effectiveness of the proposed method for Corel-1k which is a set of 1000 images that are subdivided into 10 sufficiently distinct semantic classes, including African people, seaside, bus, building, mountain, dinosaur, elephant, horses, flowers and food images some examples are depicted in Figure 4.
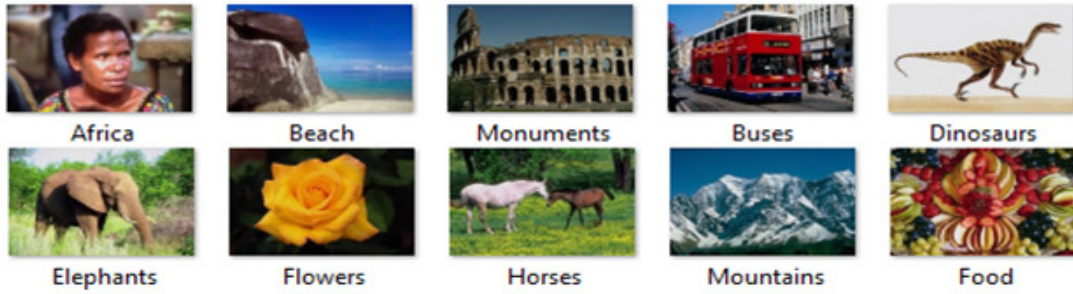
Figure 4: Image database used (Corel-1k).

3. 2 Precision-recall

Precision-versus-recall curve is the basic evaluation measure in information retrieval. They are defined as follow:

$$\text{Precision} = \frac{number\ of\ relevant\ images\ retrieved}{total\ number\ of\ relevant\ images\ retrieved} \dots\dots\dots [19]$$

$$\text{Recall} = \frac{number\ of\ relevant\ images\ retrieved}{total\ number\ of\ relevant\ images\ in\ the\ database} \dots\dots [20]$$

Table 1: Comparison precision proposed method with other methods

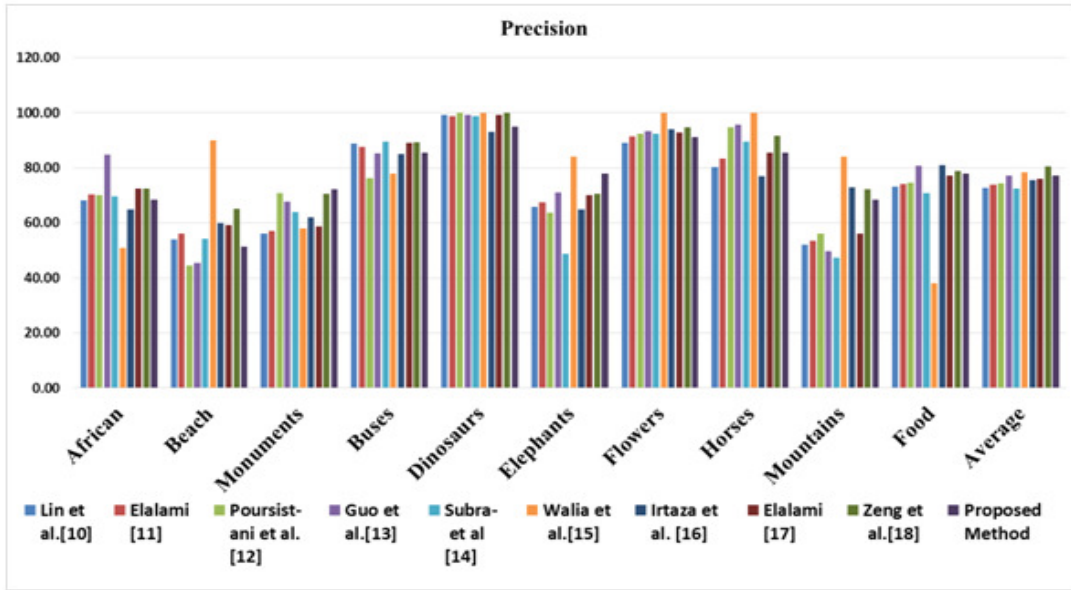| Class	Lin et al.[10]	Elalami [11]	Poursist-ani et al. [12]	Guo et al.[13]	Subra-et al [14]	Walia et al. [15]	Irtaza et al. [16]	Elalami [17]	Zeng et al.[18]	Proposed Method
African	68.30	70.30	70.20	84.70	69.75	51.00	65.00	72.60	72.50	68.40
Beach	54.00	56.10	44.40	45.40	54.25	90.00	60.00	59.30	65.20	51.30
Monuments	56.15	57.10	70.80	67.80	63.95	58.00	62.00	58.70	70.60	72.20
Buses	88.80	87.60	76.30	85.30	89.65	78.00	85.00	89.10	89.20	85.50
Dinosaurs	99.25	98.70	100.00	99.30	98.70	100.00	93.00	99.30	100.00	95.00
Elephants	65.80	67.50	63.80	71.10	48.80	84.00	65.00	70.20	70.50	77.90
Flowers	89.10	91.40	92.40	93.30	92.30	100.00	94.00	92.80	94.80	91.20
Horses	80.25	83.40	94.70	95.80	89.45	100.00	77.00	85.60	91.80	85.50
Mountains	52.15	53.60	56.20	49.80	47.30	84.00	73.00	56.20	72.25	68.40
Food	73.25	74.10	74.50	80.80	70.90	38.00	81.00	77.20	78.80	77.90
Average	72.70	73.90	74.39	77.30	72.51	78.30	75.50	76.10	80.57	77.33

Figure 5. Precision of proposed approach compared to other methods for different semantic classes in the Corel database.

Table 2: Comparison recall proposed method with other methods

| Class	Lin et al.[10]	Elalami [11]	Poursist-ani et al. [12]	Guo et al.[13]	Subra-et al [14]	Walia et al. [15]	Irtaza et al. [16]	Elalami [17]	Zeng et al.[18]	Proposed Method
African	14.10	15.30	14.04	16.94	13.95	10.20	13.00	16.10	14.50	14.46
Beach	19.20	19.80	8.88	9.08	10.85	18.00	12.00	20.30	13.04	10.98
Monuments	17.40	18.20	14.16	13.56	12.79	11.60	12.40	19.10	14.12	14.79
Buses	12.10	11.60	15.26	17.06	17.93	15.60	17.00	12.60	17.84	18.07
Dinosaurs	10.10	9.80	20.00	19.86	19.74	20.00	18.60	10.90	20.00	19.08
Elephants	14.90	15.60	12.76	14.22	9.76	16.80	13.00	16.30	14.10	16.60
Flowers	11.20	11.80	18.48	18.66	18.46	20.00	18.80	12.90	18.96	19.28
Horses	13.40	13.90	18.94	19.16	17.89	20.00	15.40	14.40	18.36	18.37
Mountains	21.30	22.80	11.24	9.96	9.46	16.80	14.60	23.60	14.45	14.34
Food	13.20	13.80	14.90	16.16	14.18	7.60	16.20	14.80	15.76	16.73
Average	14.68	15.20	14.86	15.46	14.50	15.66	15.10	16.10	16.11	16.27
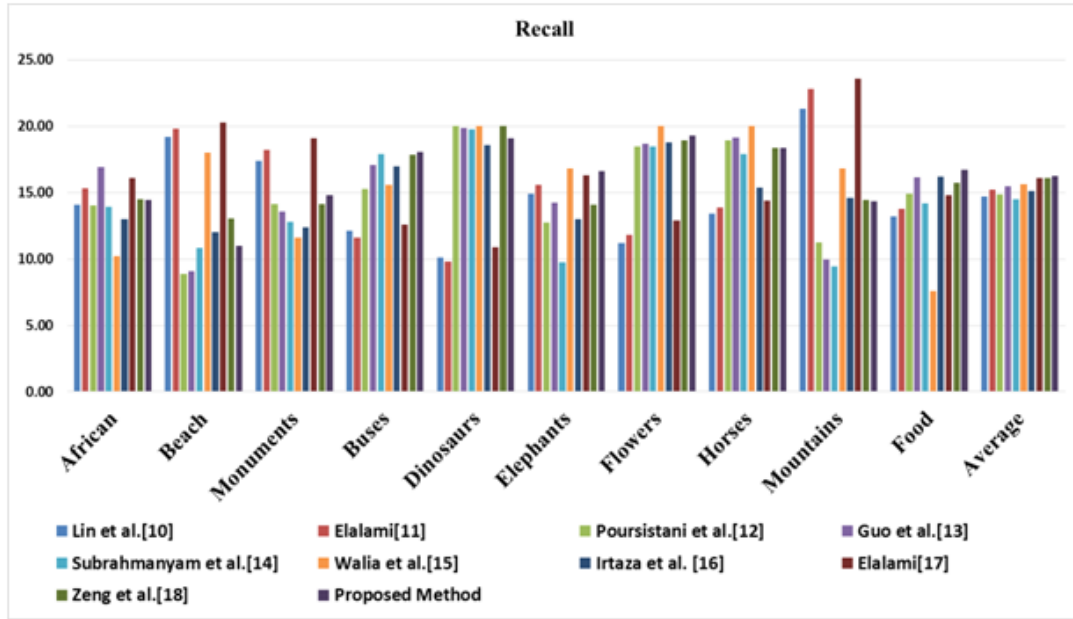
Figure 6. Precision of Proposed Approach Compared to Other Methods for Different Semantic Classes in the Corel Database
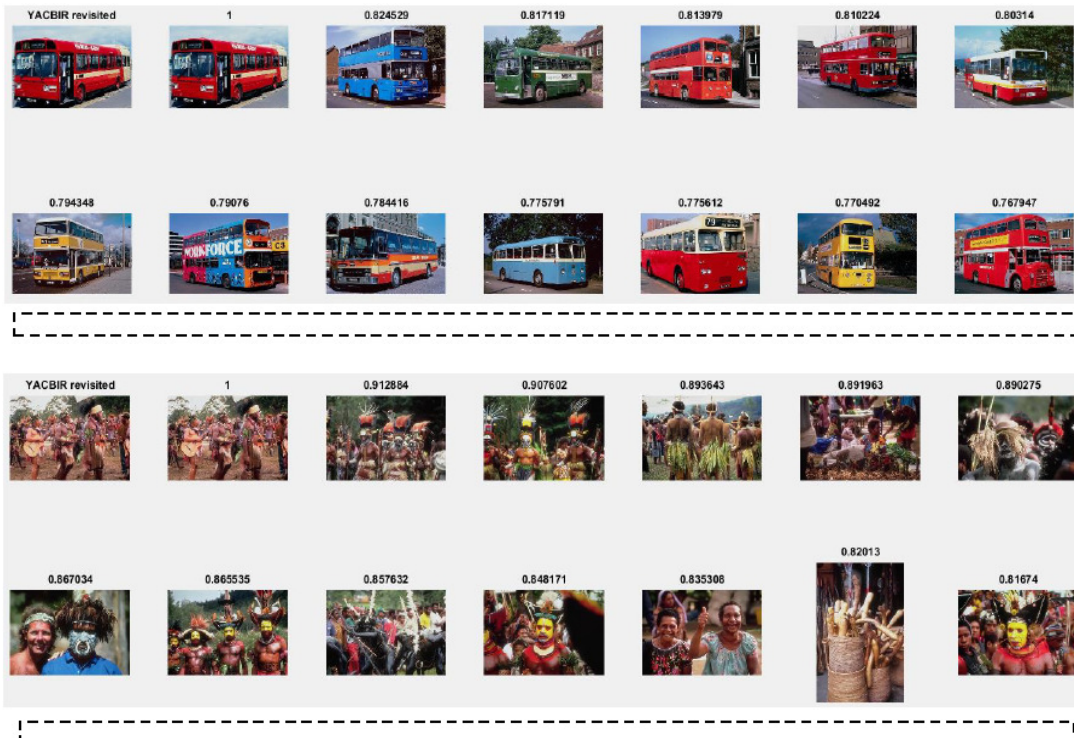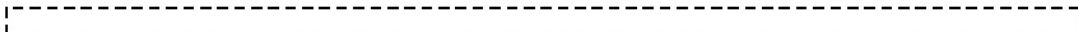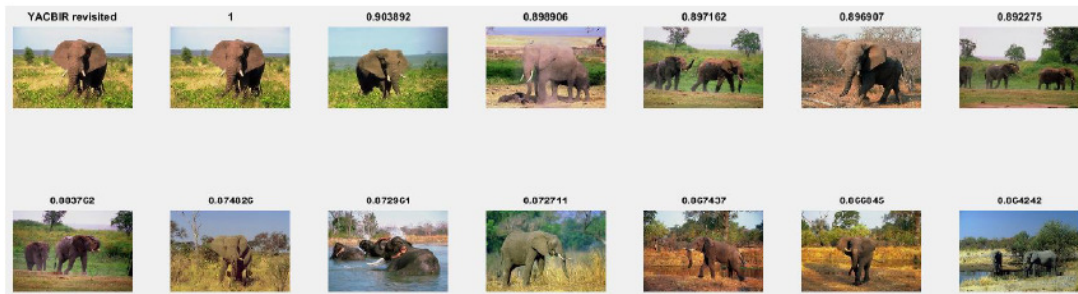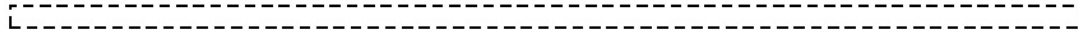
4. CONCLUSION

In this paper, we proposed an efficient learning approach based on multiple SVMs (Support Vector Machines) and YACBIR system. From the test results, we show that retrieval performance of the proposed algorithm has quite good result in the image retrieval system. In future research, other classification techniques can be tested. Artificial Neural Networks (ANN) transfer functions and multiple SVMs kernel can be used to improve the classifier performance.

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