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Implementation of SVM based CBIR System using Wavelet Transform and SIFT Approach

Ms. Yashashree Zambare[1], Prof. Dinesh D. Patil[2]

[1]PG Student, Department of Computer Science and Engineering,
Shri Sant Gadge Baba College of Engineering and Technology, Bhusawal, Maharashtra, India
[2]Associate Professor and Head, Department of Computer Science and Engineering,
Shri Sant Gadge Baba College of Engineering and Technology, Bhusawal, Maharashtra, India
[1] yashashreezambare@gmail.com; [2] dineshonly@gmail.com

Abstract— Many CBIR systems are implemented in recent years as the need for image retrieval with accuracy has increased. In this paper we proposed a new CBIR system with use of support vector machine and well known descriptor Scale Invariant Transform along with wavelet transform. The combinational approach used in proposed system is for accurate results in terms of image retrieval. SVM is used for the classification of image database for the implementation of CBIR using SIFT Algorithm. The algorithm consists of four major stages: scale-space extrema detection, keypoint localization, orientation assignment, keypoint description. This approach relies on the choice of several parameters which directly impact its effectiveness when applied to retrieve images. The proposed system has demonstrated faster retrieval method on a dataset used for calculation of experimental results. The performance evaluated yields better result as in comparison to the existing systems.

Keywords— CBIR, Image Retrieval, SIFT, SVM, Wavelet transform.

I. INTRODUCTION

In today's world image retrieval in search engine have became important, the results must be exactly obtained such is the expectations, many different methods have already been implemented but still results obtained have not been satisfactory in case where the dataset on which retrieval has to be applied is huge. In this paper we have proposed and implemented SVM based Content based image retrieval system that uses wavelet transform along with SIFT algorithm is applied for finding out first keypoint and then the exact matches. For determination of performance the precision and recall are used. For experimental purpose we have chosen the samples of 100 images of different category from WANG dataset. The rest of the paper in organized as in section two we discuss in short about related work done in CBIR system followed by our proposed system implementation and algorithm, next description about experiments conducted and representation of results and last conclusion about the implemented work.

II. RELATED WORK

Image retrieval is the field of study concerned with searching and browsing digital images from database collection. This area of research is very active research since the 1970s.The purpose of an image database is to store and retrieve an image or image sequences that are relevant to a query. CBIR can be categorized based on the type of features used for retrieval which could be either low level or high level features. Generally, three categories of methods are used for image retrieval are used: text based, content-based and semantic-based [10]. In [1] CBIR using color histograms technique is discussed using grid technique to improve performance of image retrieval. Most probably all image-processing techniques treat image as a 2-dimensional signal and apply standard techniques on it. Most CBIR system that are developed: QBIC [2], MARS [3], PicHunter [4], Photo book [5], NeTra [6] and others, In [7], authors used color feature extraction method in which color features are extracted using three techniques mainly color correlogram, color moment and HSV histogram. The main part is KNN algorithm and relative standard derivation. Use KNN classifier for classifying images and relative standard derivation used for measuring similarity between two images with finally computing value of Precision and Recall. K-Nearest Neighbours Algorithm known as KNN, supervised machine learning method that classifies data, using this classifier, set of data can be classified in order to discover elements from the set of data. In [9], authors proposed a novel image feature representation method, texture structure histogram (TSH) which is an effective image feature used for image retrieval. Some commonly used color descriptors including compact color moments, the color coherence vector, and color correlo-gram [12]. In [13] authors have proposed novel CBIR system with an optimized solution combined to K-means and k-nearest neighbour algorithm (KNN). A creative system flow model with image division and neighbourhood color topology is introduced that is designed for increasing clustering accuracy.

III.PROPOSED SYSTEM

A. Problem formulation

In today's world important research topic is CBIR, and in this paper our main focus or aim to implement CBIR system based on SIFT and wavelet features based on SVM trained set of images. The performance measurement of proposed system is done using precision and recall method. Our main aim is to improve performance of CBIR system by retrieval of exact images in result for query image. Further in this section we describe few terms.

B. Fundamentals aspects of CBIR

The Content-Based Image Retrieval, also known as query by image content and content-based visual information retrieval. Content based means that the search makes use of the contents of the images themselves, rather than relying on human-input metadata such as captions or keywords.

A content-based image retrieval system (CBIR) is a piece of software that implements CBIR. Content based image retrieval plays a central role in the application areas such as multimedia database systems in recent years. Content-based image retrieval (CBIR) is a technique to search for the most visually similar images to a given query image from a large image database. It has received increasing attentions in recent years.

C. Scale Invariant Feature Transform (SIFT)

The SIFT algorithm consists of following four major steps [];

- Scale space extrema detection,
- Keypoint localization
- Orientation assignment
- Keypoint descriptors.

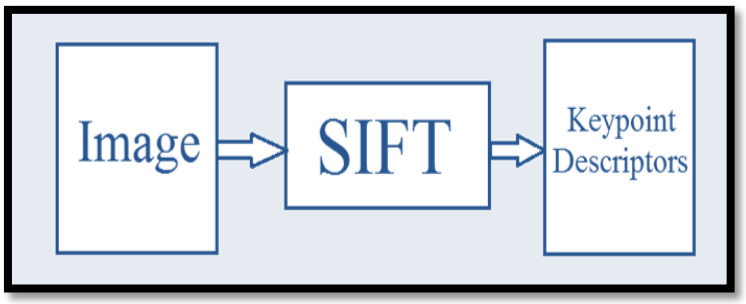

Fig. 1 Example of an unacceptable low-resolution image

The SIFT algorithm identifies features of an image that are distinct, and these features can in turn be used to identify similar or identical objects in other images. We will here give an introduction to the SIFT algorithm. SIFT has four computational phases. The output of the SIFT algorithm is a set of keypoint descriptors. SIFT takes an image as input and generates a set of keypoint descriptors as output.

D. Wavelet Transform

A multi-resolution approach is provided to texture analysis and classification due to Wavelet transforms. At each level, the signal is decomposed into four frequency sub-bands, LL, LH, HL, and HH, where L denotes low frequency and H denotes high frequency. The computation of the wavelet transforms involves recursive filtering and sub-sampling.

E. Support Vector Machine (SVM)

Support vector machines (SVMs) are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis. A support vector machine based on simple and initiative concept. They are constructed by locating the set of hyper planes that separate two or more classes of data. Support Vector Machine is a maximal margin hyperplane in feature space built by using a kernel function in gene space. This is kind of black magic we do not know what happens inside the kernel, we just get the output. Still, we have the geometric interpretation of the maximal margin hyperplane, so SVMs are more transparent than e. g. Artificial Neural Networks. The support vector machine is a powerful tool for bi-nary classification, capable of generating very fast classifier functions following a training period.

F. Proposed System

The workflow for proposed system is as stated below

Step 1. *Start*
Step 2. *Firstly input any query image or test image as input to system*
Step 3. *Once we load query image then accordingly trains the SVM for labelling all images.*
Step 4. *Next is to separate out all the labelled images from the whole dataset for further feature calculations namely SIFT and Wavelet Transforms to be applied.*
Step 5. *After SVM training compute SIFT features. Keypoint found are localized.*
Step 6. *Then calculates the wavelet features*
Step 7. *Apply Level 1 wavelet on query image to decompose into four frequencies LL1, LH1, HL1, and HH1 respectively.*
Step 8. *Apply Level 2 wavelet on LL1 image to decompose into four frequencies LL2, LH2, HL2, and HH2 respectively.*
Step 9. *Apply Level 3 wavelet on LL2 image to decompose into four frequencies LL3, LH3, HL3, and HH3 respectively.*
Step 10. *Next important step is combining features extracted in earlier steps and retrieve images.*
Step 11. *Images are indexed as per number of matches in descending order of matches found.*
Step 12. *At the end relevant images retrieved to query image are shown as result.*
Step 13. *Continue with another Query Image with repeating above steps or Exit the application*

IV. EXPERIMENTAL RESULTS

The proposed system work is implemented in MATLAB. The dataset used for performing experiments in WANG dataset[]. We have used approximately 100 images in five different categories for demonstration purpose details of which are shown in figure 2.

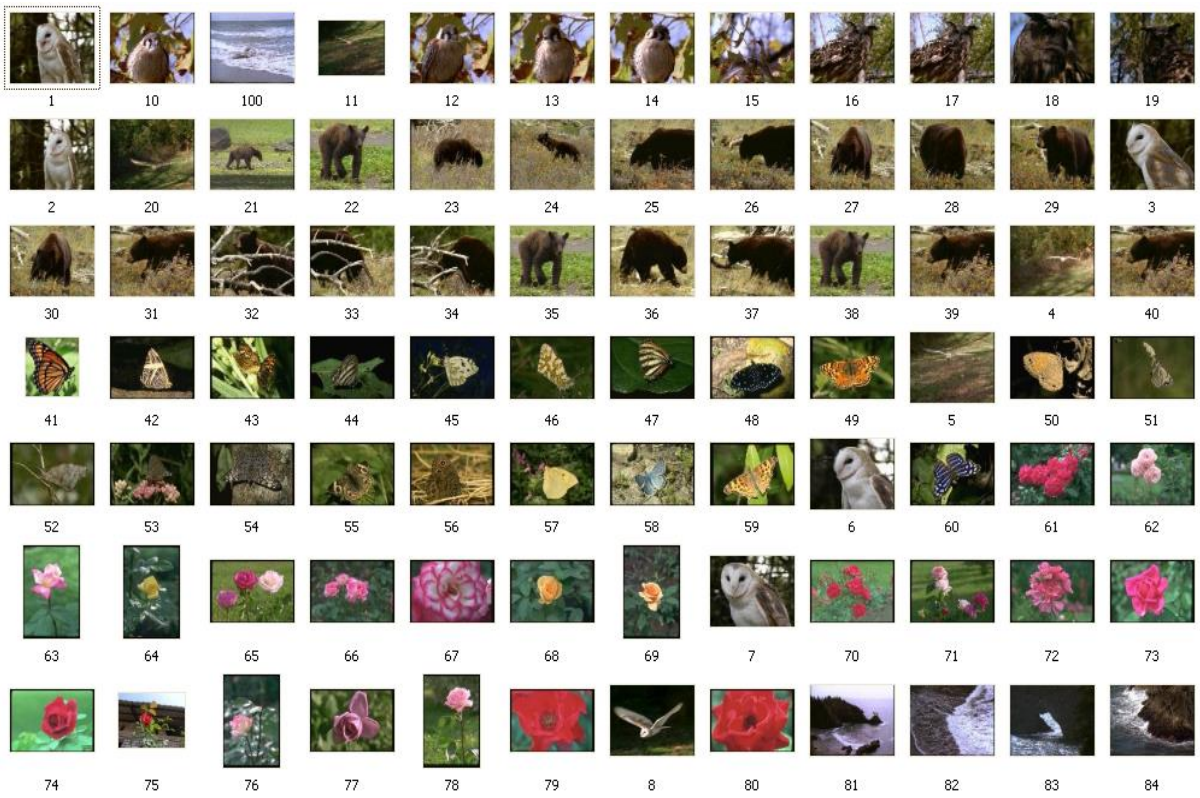

Fig. 2 WANG dataset of 100 images with five categories

The query images details used for experimentation are illustrated in Table 1.

TABLE I

DESCRIPTION OF DIFFERENT SAMPLE QUERY IMAGES USED

Sr. No.	Image title	Category	Dimensions in pixels
1.	49.jpg	Butterfly	128 x 96
2.	94.jpg	Beach	128 x 96
3.	12.jpg	Bird	128 x 96
4.	71.jpg	Flower	128 x 96
5.	35.jpg	Animal	128 x 96

Figure 3 shows the initial user interface of the implemented system that appears on execution of code, also GUI is kept simple for ease of access, after section of Query Image by click on the Load Query image the query image get loaded as shown in figure 4. After clicking on the Retrieve relevant images the intermediary steps are performed as shown in figure 5 and 6. Then the wavelet and SIFT features gets applied and relevant images are retrieved with top left corner images as the best result or exact match for query image as shown in figure 7.

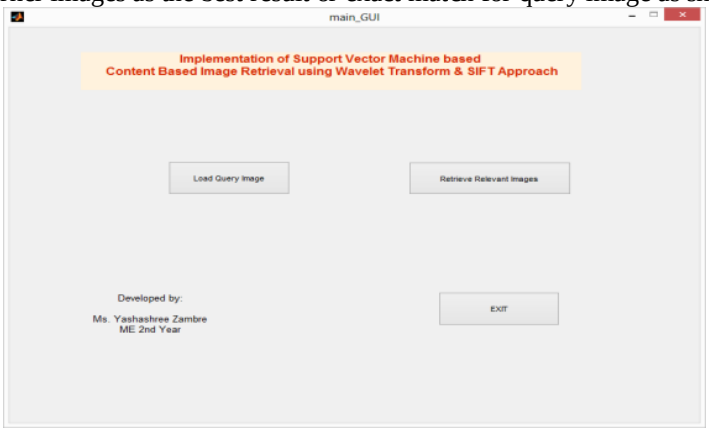

Fig. 3 GUI of Proposed System

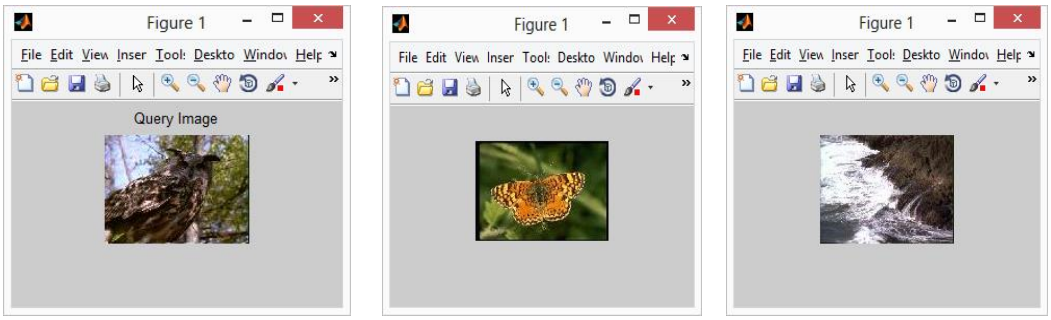

Fig. 4 Query image loaded after click on Load Query Image button in GUI

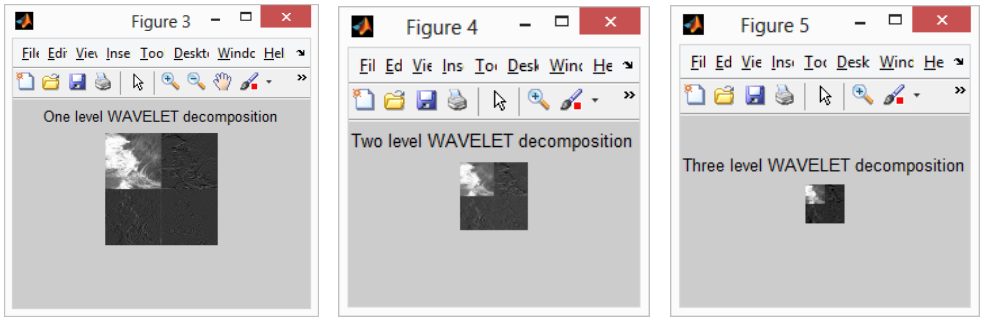

Fig. 5 Wavelet features decomposing image upto level 3

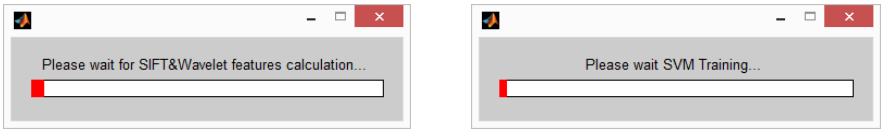

Fig. 6 Intermediate progress interface during background calculations

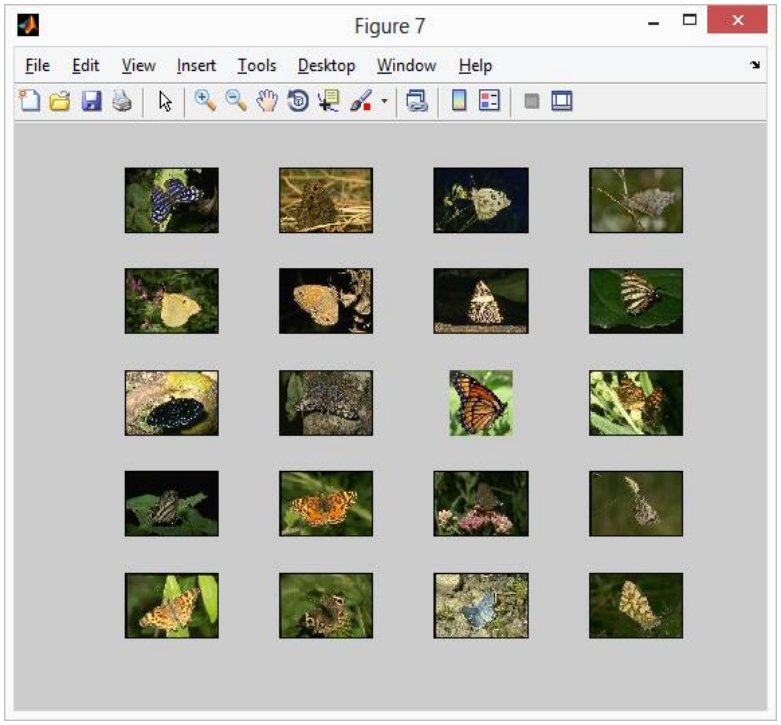

Fig. 7 Relevant images retrieved for image 49.jpg

The calculations for images 49.jpg and 94.jpg are shown in table 2 which shows comparison with the match percent along with SIFT keypoint extracted for relevant image of category by the proposed system.

TABLE III

For Image 49.jpg category - butterfly				For Image 94.jpg category - Beach			
RETRIVED IMAGES FROM DATASET	**KEYPOINTS FOUND**	**MATCHES**	**MATCH %**	**RETRIVED IMAGE FROM DATASET**	**KEYPOINTS FOUND**	**MATCHES**	**MATCH %**
49	96	52	100.00	94	131	94	100.00
51	22	27	51.92	96	108	41	43.62
53	152	24	46.15	89	24	37	39.36
44	75	19	36.54	98	84	31	32.98
50	81	18	34.62	84	95	30	31.91
55	80	18	34.62	86	100	30	31.91
57	185	18	34.62	91	73	30	31.91
59	121	18	34.62	95	153	30	31.91
60	152	18	34.62	93	71	27	28.72
45	79	17	32.69	83	50	26	27.66
48	116	17	32.69	85	110	26	27.66
43	122	16	30.77	87	62	26	27.66
58	139	16	30.77	90	54	26	27.66
42	46	15	28.85	97	98	26	27.66
56	191	14	26.92	100	99	26	27.66
47	63	13	25.00	99	53	25	26.60
52	56	13	25.00	81	63	23	24.47
54	104	13	25.00	82	113	23	24.47
46	84	11	21.15	92	71	23	24.47
41	147	9	17.31	88	45	22	23.40

For performance measurement precision and recall is used, which is calculated using formulas illustrated as below and table 3 shows results of values of precision and recall. Precision is defined as the fraction of retrieved images which is relevant to a query. In contrast, recall measures the fraction of the relevant images which has been retrieved.

$$\text{Precision} = \frac{\text{No. of relevant images retrieved}}{\text{Total no.of irrelevant and relevant images retrieved}}$$

$$\text{Recall} = \frac{\text{No. of relevant images retrieved}}{\text{All relevant in Database}}$$

Sr. No.	Category	Query Image no.	Precision	Recall
1.	Butterfly	49	0.9	0.9
2.	Beach	94	0.8	0.8

V. CONCLUSIONS

In this paper we proposed and implemented a new CBIR system with use of support vector machine and well known descriptor Scale Invariant Transform along with wavelet transform. The combinational approach used in proposed system is for accurate results in terms of image retrieval. SVM is used for the classification of image database for the implementation of CBIR using SIFT Algorithm. The experimental results shows that the performance of system on proposed system is near about accurate and precision values proves it. The SVM training along with features of SIFT and wavelet results in better and accurate performance of system in terms of image retrieval.

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