Local and Multiresolution Analysis for Content-Based Image Retrieval (CBIR) Monument Recognition as a Touristic Support

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AIM

Design and Development of a Content-Based Image Retrieval (CBIR) system to be used for large amounts of distributed images. As an application, the platform can be adapted for monument recognition and touristic support

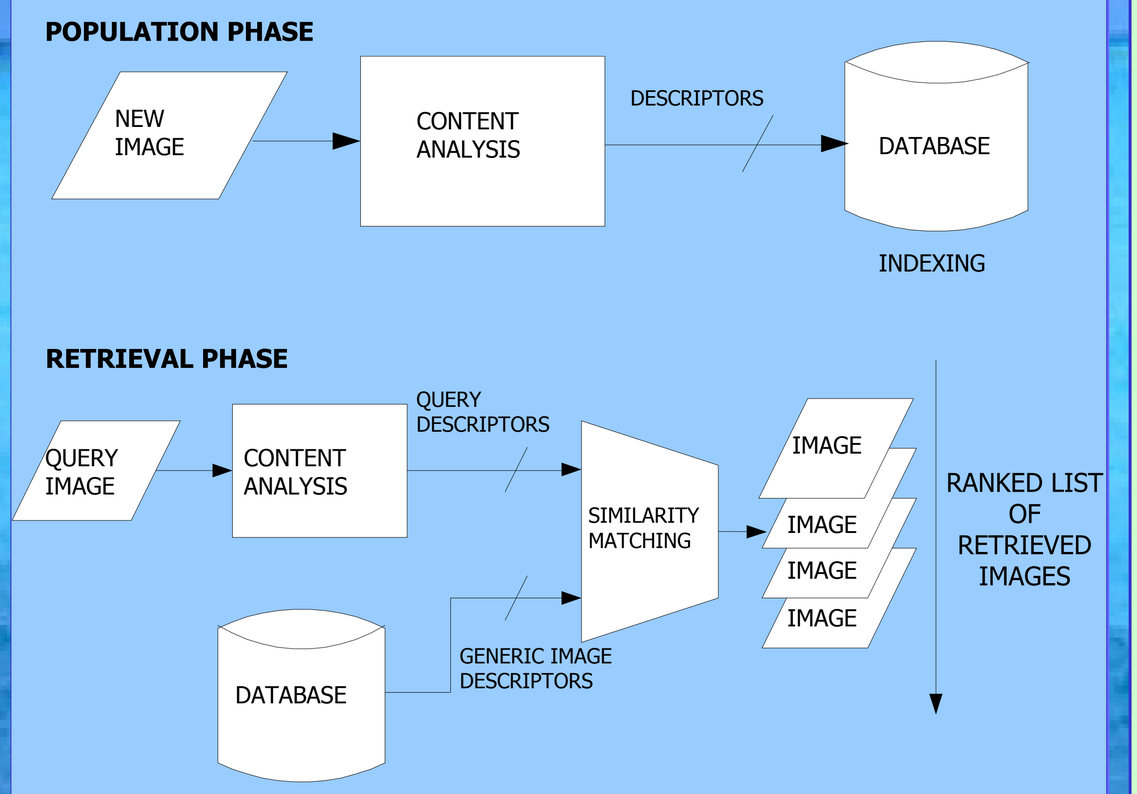
WHY

Digital multimedia archives, often shared on web, are rapidly increasing their diffusion. Such large amounts of images need efficient techniques of management and retrieval. In this context, CBIR systems can be useful to perform database queries based on similarity criteria. The Monument Recognition task has been focused in the context of a research project with Telecom Italia Lab in order to provide a context aware touristic service for mobile users. The application allows also a better management of large personal multimedia archives, thanks to the automatic tagging of the photos.

HOW

Kingfisher [1] generates a physical structured representation of images by applying segmentation techniques to locate objects and by exploiting global and local information based on color, shape and texture features. For the monument recognition application, multiresolution analysis using wavelet transform has been added. The distributed architecture provides remote content-based retrieval for images database and allows large number of users to consult large quantities of data. The architecture is expandable and modular and its client/server functionalities allow to easily build web applications that can be run using any browser web without compatibility problems related to platform, program language, database technology.

Stages of Population and Retrieval Phases



SIMILARITY MATCHING

- **When a query image (Q) is compared with the database images, each region of Q is compared with the regions of the images. Distance functions, such as *Minkowsky Metric, Absolute Distance* or *Bhattacharyya distance*, are used for this purpose.**
- **Each distance is then converted into a similarity score using the following functional mapping:**

$$H(x)=exp(-x)$$

- **After that, similarity scores related to each 'predicate' or feature vector are combined with the following criteria:**

$$similarity(Q^r, O^j) = \sum_i w_i similarity(Q_i^r, O_i^j)$$

where O^j is an object, or region, of the compared image, Q_i^r, O_i^j are the *i* predicates of the query region and the candidate object and $\Sigma_i w_i=1$.

- **Total image score is finally assigned on the basis of the best matching region O^j**

When wavelet analysis is performed, similarity score is computed only on the basis of the Euclidean distance between the image feature vectors.

RESULTS AND FUTURE WORKS

- **Preliminar tests have been performed using about 70 images belonging to 4 classes (monuments). The number of the retrieved images for each test session corresponds to the size of the considered class sample → Precision and Recall are represented by the same value. Results show better performances using multiresolution analysis.**

	Segmentation	Multiresolution analysis
Precision/Recall	**48.78%**	**62.59%**

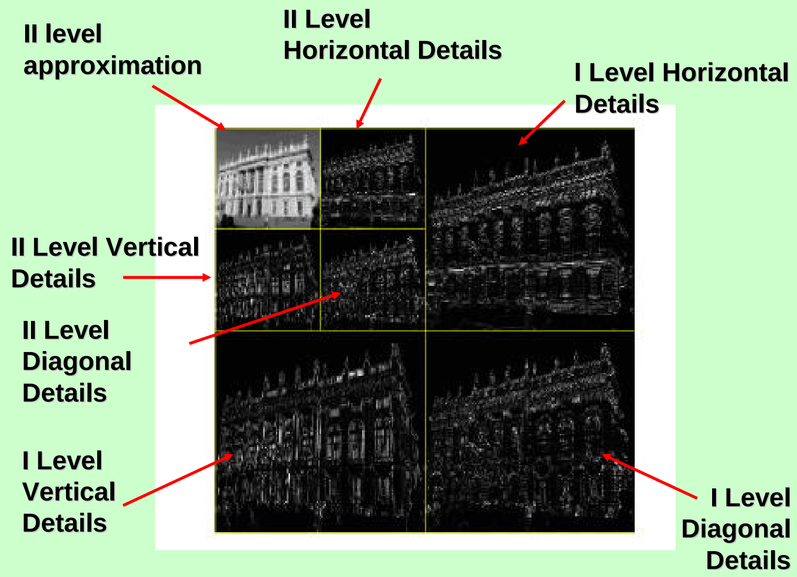
- **Future work will include a real more significant test phase with larger number of classes and images, the study of an appropriate classifier-combination method and the implementation of a relevance feedback technique.**

CONTENT ANALYSIS: SEGMENTATION & MULTIRESOLUTION ANALYSIS

Segmentation techniques are used to extract local information with the aim of locating the relevant objects contained in the images.
The following segmentation techniques are supported:

- Multi-Thresholding (color or grey space)
- Mathematical Morphology
- Region Growing
- Fuzzy Isocontours [1]

For the application of Monument Recognition, a multiresolution analysis, based on the global image, has been implemented. It is related to the edges of the objects contained in the image. Haar wavelet transform has been used.



CONTENT ANALYSIS: FEATURE EXTRACTION

Feature are extracted in order to characterize the found objects / the various levels of the images.
Some features preserve spatial information while other features are more related to the statistic behavior of the objects.

GLOBAL FEATURES

Measures are extracted from the whole image.

LOCAL FEATURES

Measures are extracted from the each segmented region of the image.

From the main *segmented regions* the following features are extracted:

Colour	*Texture*	*Shape*
Color Histogram Mean Color Color Distribution	Spatial correlation Tamura Gabor wavelet	Area / Perimeter Elongation/ Fitting Dissimetry / Projections Edge Directions Invariance Moments Fourier Descriptors Polar Represantation

From *wavelet coefficient matrices* local mean energies of the I and II level horizontal and vertical wavelet details are computed and stored in a feature vector.

REFERENCE

[1] M. Antonelli, S.G. Dellepiane, M. Goccia, "Design and Implementation of Web-Based Systems for Image Segmentation and CBIR", IEEE Trans. On Instrumentation and Measurement, Dec. 2006, Vol. 55, Issue 6, pagg. 1869-1877