

IMAGE SEGMENTATION SEARCH ENGINE: ADVANCED ACCESS TO AN IMAGE ARCHIVE DATABASE

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ABSTRACT

As long as innovative channels are going to be accessible, the digital archives need to integrate new technologies and services for digital image processing and delivery. The possibility to search images by means of features and other images and not only with keywords, seems to be an important challenge. The Alinari's image-archive research department is testing some specific search agents able to "retrieve images by images": a customer could be interested to find all the images that are somehow similar to one specific image he chooses (i.e. a family photo). European SCHEMA project (IST-2001-32795) is currently working on object and region segmentation algorithms and with the Qimera platform has obtained very good results. This paper refers to Alinari's application cases and tests¹.

Index Terms — digital image segmentation, QIMERA, IPR management, search engines, digital image archiving, artificial vision.

1. INTRODUCTION

The Qimera initiative is a pan-European collaborative voluntary research project having as objective the developing of a flexible modular software architecture for video object segmentation and tracking which can be used as a vehicle and test-bed for collaborative algorithm development.

During the last years image archives and generally speaking, digital content providers, have created their web sites getting in contact with new market segments both for business and for educational purposes.

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Archives and cultural institutions are developing distributed configurations of contents and services as well as new search engines adaptable to the users needs. This involves the developing of new processes not only for the search but also for the content management: from the image generating to the cataloguing or information adding. An important consequence of the image segmentation technology is also the evaluation of new IPR issues and content protection procedures: the improper and illegal usage of protected images will be detected more easily.

This paper describes some use cases defined for archive users and some first results obtained by testing activities.

2. APPLICATION CASES

The image segmentation software has the capability to generate information from a set of images, this information could constitute a new vocabulary that can be interfaced with the text databases. The segmentation of an image and information generating are clearly innovative processes that will allow to develop new instruments for content retrieval architectures.

During the last years many content providers (museums, archives, libraries) have developed new business giving access through internet to their contents. Some of the major image archives (as well as video and footage archives) have developed search engines to let the users retrieve images and related contents such as text or audio. These search engines need as input keywords or even coded numbers. The need of words implies not only personal capabilities of selection but also language and vocabulary knowledge and still the results could be not relevant or even too large (later refinements are often needed). The image-archive requires a specific search agent able to "retrieve images by images". This means that a customer could be interested to find all the images that are somehow similar to one specific image he chooses. Moreover, the search by keywords inside an image data base could be a limitation to the needs of particular user groups. Actually new automatic search spiders should also find images somehow similar to a given one or to a simplified representation (i.e. a

drawing). As example consider a language use case: a foreign-language-user (referring to the archive database language) will be able to retrieve images which are similar to a given one he owns.

Selected users have been interviewed in order to define specific application cases and tools. The interviews have been executed considering some big domains as educational, business and medical.

Considering the educational domain, a researcher could find historical images starting from a portrait or a family photo. From the medical domain there is sometimes the need to find the images from the database that have commune features to the one under analysis referring some disease. Then in the business domain a graphic studio could be interested to find real images that could be similar to some freehand drawings. Recently defined application cases require integration of technologies, as example the scanned UV image of a painting could be automatically elaborated by a segmentation software and after revealing the image features we could extract the information relating it to a specific thesaurus and comparing the processed image (still during the same direct process) with other images inside the database revealing similarities and key elements.

When considering digital contents such as images or video excerpts, the owners of the content ask for strong IPR management system. The segmentation software could contribute to detect copyright protected images.

The application cases inside the artificial vision domain are much more than the few described here. The image archive application cases underline the need for the user to be able to insert as input an image (a photo of a real subject or a drawing or even only a distribution of colours) and having as output a set of images retrieved on the basis of the image features. Of course this new approach is not intended to be completely separated from the traditional keyword-based engines, on the contrary the two approaches are supposed to be integrated together.

3. ANALYSIS TECHNIQUES

The Qimera software uses a graphical user interface that is platform independent and through the communication interface lets the user activate different engines. The image analyzer engines have been developed by the project technical partners realizing different operative modules. The analysis techniques that are under testing, use two approaches to the segmentation: the region-based segmentation and the object-based segmentation [1,2,3].

The region-based segmentation module can activate the following algorithms:

- Recursive Shortest Spanning Tree (RSST) algorithm.
- K-Means-with-connectivity-constraint (KMCC).
- EM-based segmentation in 6D color/texture space.

- Pseudo Flat Zone Loop Algorithm .

The object-based segmentation module can activate the following algorithms:

- Semi-automatic segmentation via modified RSST.
- Level-set based snake segmentation .

4. THE ARCHITECTURE OF THE SYSTEM

The input image can be selected from a ready set images or uploading personal images by means of a graphical user interface and activating the Qimera segmentation. The Qimera system will process the segmentation using the previously listed techniques and the modules (Inference Engines) will combine the results producing as output a final segmented image. After the image has been semantically analyzed, the extracted regions can be evaluated and associated to the database items. Lastly the results of the search will be visualized within the same graphical interface to the user.

The requirements stated by the image archive and concerning the new architecture can be listed here:

Low costs: the process of segmentation must be executed only the first time an image is added to the data base.

Robustness : the application does not crash.

Performance: the process must be quick and the results meaningful (not high under-segmentation nor over-segmentation errors).

Scalability: images and contents can be added or removed without reconfiguring the architecture and the possibility to upgrade the software tools without conflicts among new components.

Security: the system is expected to reveal if input images belong to the archive or not.

Distributed architecture: in a future step, different archives could share a commune interface and commune search engines which results will be extracted from separate data bases.

Image file formats: to define which format will be implemented (at this time as example the new jpeg2000 file format can't be used as input file to the segmentation algorithm).

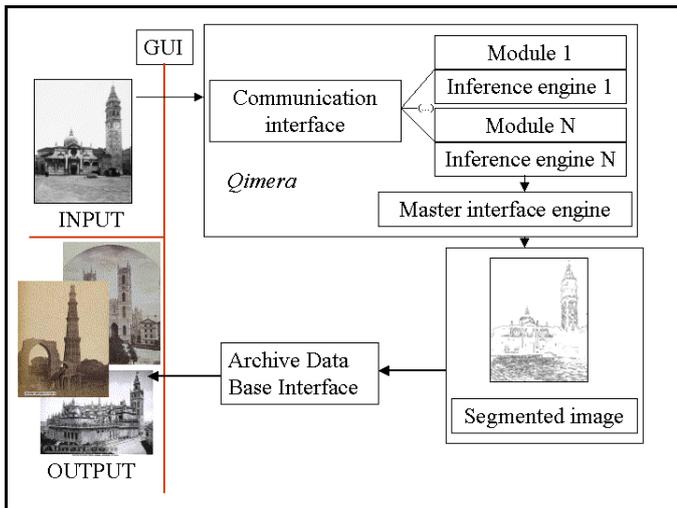


Figure 1: Query workflow with evidence on the Qimera process.

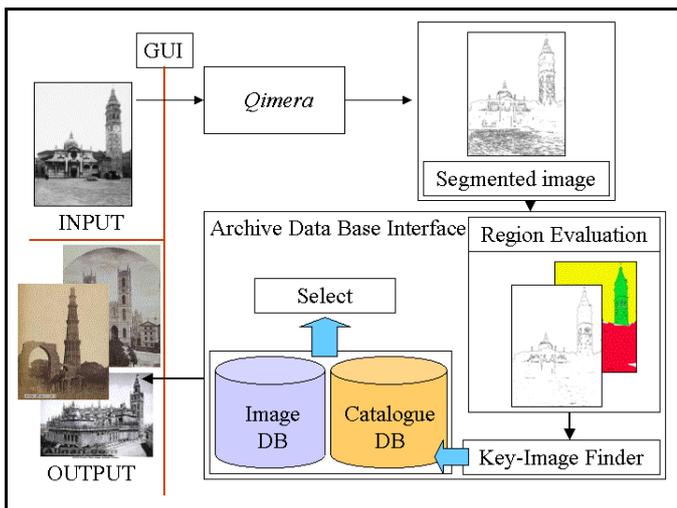


Figure 2: Query workflow with evidence on the archive data base interface block diagram.

5. EVALUATION

The evaluation of the segmentation software refers to measurements of spatial contour accuracy, to the number of regions produced by the segmentation algorithm, to the absolute area error and to the quality of the segmentation. The average number of regions produced by each algorithm changes significantly for the same test image (the maximum number is usually generated by the Modified RSST algorithm, while the Level-set based snake segmentation generates the minimum number of regions).

A similarity threshold will let the comparison with the database images. Combining keywords engine and image similarity engine (colour, texture, position, shape) the results that are obtained are much more adherent and the process optimised.

The semi-automatic object segmentation [1,4] offered by Qimera, allows the interaction by the user who initially defines what objects to be segmented on the input image. The user selection will be then processed and eventually again refined interactively. The semi-automatic segmentation feature will have important application as up to now, all the users that were interviewed, showed real needs for interaction and refinement of their searches.

6. INTEGRATION

New file formats, such as JPEG2000, are not yet included in the set of file formats capable to be segmented but this is not a limit now. The JPEG2000 standard will include most of the features required by image archives (JPWL for wireless; JPSEC for security and access control; JPIP for interactivity and interoperability; JP3D for volumetric and 3D imaging) which means that the integration inside any segmentation software will be a future requirement.

Many digital archives offer navigation and business services trough the Web, the mobile technologies have already been integrated (as example, some image archives provide multimedia messaging contents: images with simple text messages and jingles) but the possibility to access the content is still low efficient and a segmentation engine could generate better performances.

The demand for services generates also new problems to be solved and the most pressing one is the security and Intellectual Property Right management and monitoring.

The possibility to search images in a fast way and to be able to use content retrieved inside an interactive architecture, lets the archive offer not only images but also new services as the market demand pushes towards products that can be easily retrieved and immediately included in other products or services. As long as innovative channels are going to be accessible, the digital archives need to integrate new technologies and services for digital image processing and delivery.

7. CONCLUSION AND FUTURE WORK

The Qimera tests have given good results, the evaluation of the analysis techniques will allow to calibrate the system optimising the output. This architecture is expected to be integrated inside the search engines already in use. It should also be able to be used in a distributed mode: different image archives (such as Alinari and Austrian National Library and smaller archives) are going to test a shared interface with localized databases. This engine system will allow a new aggregation reason for image archives (or libraries; hospital repositories; educational institute repositories; etc.). This means that many archives could share the same interface giving trusted results from the partners.

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