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Searching Images Segmented from Search Engine database using sophisticated QIMERA method of Algorithm

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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 someway 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 tests.**

I. INTRODUCTION

Image segmentation is an important technology for image processing. There are many applications whether on synthesis of the objects or computer graphic images require precise segmentation. With the consideration of the characteristics of each object composing images in MPEG4, object-based segmentation cannot be ignored. Nowadays, sports programs are among the most popular programs, and there is no doubt that viewers' interest is concentrated on the athletes. Therefore, demand for image segmentation of sport scenes is very high in terms of both visual compression and image handling using extracted athletes. In this project, we introduce a basic idea about colour information and edge extraction to achieve the image segmentation. The colour information helps obtain the texture information of the target image while the edge extraction detects the boundary of the target image. By combining these, the target image can be correctly segmented and represent. Besides, because colour information and edge extraction can use basic image processing methods, they can not only demonstrate what textbook claims but also make us realize their function works. We expect that we can extract most part of the target. There are many algorithms used for image segmentation, and some of them segmented an image based on the object while some can segment automatically.

Nowadays, no one can point out which the optimal solution is due to different constraints. In [1], a similarity close measure was used to classify the belonging of the pixels, and then used region growing to get the object. Unfortunately, it required a set of markers, and if there is an unknown image, it is hard to differentiate which part should be segmented. Linking the area information and the colour histogram were considered for building video databases based on objects [2]. However, the colour information has to be given first, and it is not useful for the life application. A genetic algorithm adapted the segmentation process to changes in image characteristics caused by variable environmental conditions [3], but it took time learning. In [4], a two-step approach to image segmentation is reported. It was a fully automated model-based image segmentation, and improved active shape models, line-lanes and live-wires, intelligent scissors, core-atoms, active appearance models. However, there were still two problems left. It is strong dependency on a close-to-target initialization, and necessary for manual redesign of segmentation criteria whenever new segmentation problem is encountered. The authors in [5] proposed a graph-based method, the cut ratio is defined following the idea of NP-hard as the ratio of the corresponding sums of two different weights of edges along the cut boundary and models the mean affinity between the segments separated by the boundary per unit boundary length. It allows efficient iterated region-based segmentation as well as pixel-based segmentation. Moreover, in order to understand an image and recognize the represented objects, it is necessary to locate in the image where the objects are [6]. The homogeneity between two pixels and the distance function are included to measure the segmented results DI =| I (x, y) - I (v,w) | [7]. In [6], a confidence level L= min(p_i- p_j),i, j 1,...,N is used as a new performance measure to evaluate the accuracy segmentation algorithm. In [8], the minimizing function including the approximation mean square error RMSE and the number of distinct region tried to achieve a good segmentation result.

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. 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 trough 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 someway 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.

II. 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 [9, 10, 11].

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 colour/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.

III. 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).

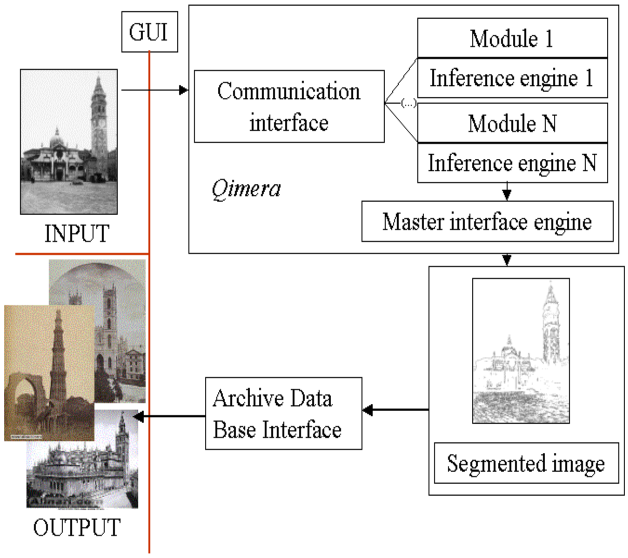

Figure 1: Query workflow with evidence on the Qimera process.

Image segmentation has an important role in image processing and the speed of the segmentation algorithm may become a drawback for some applications. This study analyzes the run time performances of some variations of the recursive shortest spanning tree algorithm (RSST) and proposes simple but effective modifications on these algorithms to improve their speeds. In addition, the effect of link weight cost function on the run time performance and the segmentation quality is examined. For further improvement in the run time performance of the fastest sequential method, a distributed RSST algorithm is also proposed and evaluated. Speed is a great concern in the recursive shortest spanning tree (RSST) algorithm as its applications are focused on image segmentation and video coding, in which a large amount of data is processed. Several efficient RSST algorithms have been proposed in the literature, but the linking properties are not properly addressed and used in these algorithms and they are intended to produce a truncated RSST.

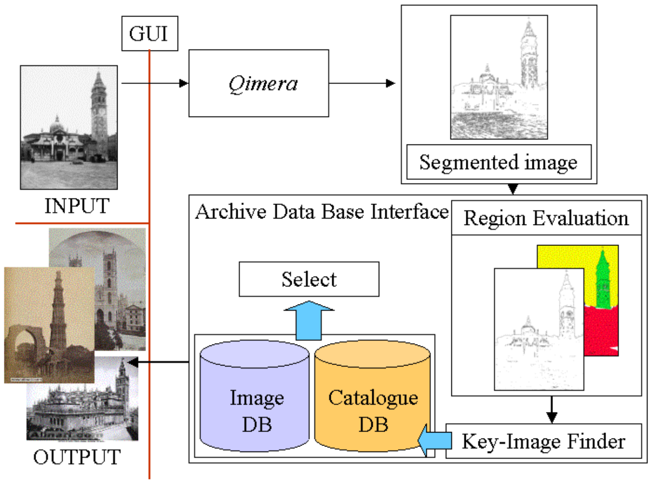

Figure 2: Query workflow with evidence on the archive data base interface block diagram.

Clustering is traditionally viewed as an unsupervised method for data analysis. However, in some cases information about the problem domain is available in addition to the data instances themselves. . In experiments with artificial constraints on six data sets, we observe improvements in clustering accuracy. We also apply this method to the real-world problem of automatically detecting road lanes from GPS data and observe dramatic increases in performance.

Clustering algorithms are generally used in an unsupervised fashion. They are presented with a set of data instances that must be grouped according to some notion of similarity. The algorithm has access only to the set of features describing each object; it is not given any information (e.g., labels) as to where each of the instances should be placed within the partition. However, in real application domains, it is often the case that the experimenter possesses some background knowledge (about the domain or the data set) that could be useful in clustering the data. Traditional clustering algorithms have no way to take advantage of this information even when it does exist.

The expectation-maximization algorithm (EM) is used for many estimation problems in statistics. Here we give a short tutorial on how to program a segmentation algorithm using EM. Those interested in the theory or in more advanced versions of the algorithm should consult the references at the end. Suppose we are given a set of data points that were generated by multiple processes, for example two lines. We need to estimate two things:

(1) The parameters (slope and intercept) of the two lines and

(2) The assignment of each data point to the process that generated it. The intuition behind EM is that each of these

steps is easy assuming the other one is solved. That is, assuming we know the assignment of each data point, then we can estimate the parameters of each line by taking into consideration only those points assigned to it. Likewise, if we know the parameters of the lines we can assign each point to the line that fits it best.

This gives the basic structure of an EM algorithm:

- Start with random parameter values for the two models.
- Iterate until parameter values converge:

E step: assign points to the model that fits it best.

M step: update the parameters of the models using only points assigned to it. In fact both steps are slightly more complicated, due to the assignment being continuous rather than binary valued. The following sections go into more detail regarding the E step and the M step.

IV.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 [9,12] 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.

V. 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 through 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.

VI. 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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