INRIA

INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

# *Project-Team Qgar*

# *Querying Graphics Through Analysis and Recognition*

*Nancy - Grand Est*

THEME COG

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# 1. Team

**Research Scientist**

Gérald Masini [ research scientist, currently head of the Information Technology Service ]

Karl Tombre [ professor at INPL/Écoles des Mines on secondment to INRIA, currently director of INRIA Nancy-Grand Est Research Center, HdR ]

**Faculty Member**

Salvatore Tabbone [ Team Leader, professor, Université de Nancy 2, HdR ]

Suzanne Collin [ assistant professor at UHP/ESIAL ]

Philippe Dosch [ assistant professor at Université de Nancy 2/IUT Charlemagne ]

Bart Lamiroy [ assistant professor at INPL/École des Mines de Nancy ]

Benoît Naegel [ assistant professor at UHP/IUT Saint-Dié ]

Oriol Ramos Terrades [ ATER at Université de Nancy 2, from January to August ]

Laurent Wendling [ assistant professor at UHP/ESIAL, HdR ]

**Technical Staff**

Vincent Meslard [ INPL/École des Mines de Nancy, from July to August ]

Vitor Vasconcelos Araújo Silva [ engineer under ODL contract ]

**PhD Student**

Sabine Barrat [ PhD student at Université de Nancy 2, 1/2 ATER Université Henri Poincar, defense planned in 2009 ]

Thai Hoang Van [ PhD student at Université de Nancy 2, funded by a BDI PED CNRS contract, defense planned in 2011 ]

Santosh K.C. [ PhD student at INPL, funded by a CORDI INRIA grant, defense planned in 2011 ]

Oanh Nguyen [ PhD student at Université de Nancy 2, joint supervision with IFI (Hanoi, Vietnam), defense planned in 2009 ]

Salim Jouili [ PhD student at Université de Nancy 2, employed by INRIA on Navidomass project, defense planned in November 2010 ]

Jean-Pierre Salmon [ PhD student at INPL, employed by INPL on European project FRESH, defense planned in December 2008 ]

**Visiting Scientist**

Djemel Ziou [ professor at Université de Sherbrooke (Canada), visiting Qgar in December ]

Nhu Van Nguyen [ PhD student at IFI Hanoi, visiting Qgar from July, 15 to September, 30 ]

Nafaa Nacereddine [ PhD student at Ecole Nationale Polytechnique d'Alger, from October 2008 to Avril 2010 ]

Hassan Chouaib [ PhD student at Université de Paris 5, in March ]

**Administrative Assistant**

Maria Plancy [ TR INRIA, from January to May ]

Christelle Wagner [ TR INRIA, from August ]

Françoise Laurent [ SASU INPL for budget support at INPL/École des Mines de Nancy ]

# 2. Overall Objectives

## 2.1. Overall Objectives

The Qgar project-team works on the conversion of weakly structured information—an image of a paper document, or a PDF file, for example—into "enriched" information, structured in such a way that it can be directly handled within information systems. Our research belongs to the document analysis field, and more precisely to the graphics recognition community. We study the use of graphics recognition methods to index and organize weakly structured graphical information, contained in *graphics-rich documents*, such as technical documentation. In this context, we experiment the capacity of pattern recognition methods

to compute useful features for indexing and information retrieval. However, as the semantics (or domain knowledge) of the processed information cannot be fully taken into account, this community is well aware of the fact that recognition alone will not lead to completely automated back-conversion. Graphical information, such as symbols or drawing parts must be complemented with the handling of text-based retrieval (based on annotations or textual references, for instance) methods.

# 3. Scientific Foundations

## 3.1. Introduction

Our scientific foundations belong in the domain of image analysis and pattern recognition. For many years, the main contributions of our project-team were in the area of algorithms and methods for image analysis and segmentation, with a specific focus on images of graphics-rich documents. In the last years, while keeping a regular activity in this domain, we have moved our main effort towards pattern recognition methods, especially for symbol recognition and spotting. But, of course, recognition tasks also require the prior extraction of features, using image processing and segmentation methods.

## 3.2. Feature Extraction and Segmentation

**Keywords:** *Binarization*, *image processing*, *text-graphics segmentation*, *vectorization*.

As conversion from pixels to features raises a great deal of problems, our project-team had to design several algorithms and methods for binarization, vectorization or text-graphics segmentation. However, designing new methods, or variants of older ones, is not enough. We also must be able to characterize and to evaluate the performances of the methods we use, to study their robustness and reliability, and to develop stable implementations for them (hence, the focus on software, cf. § 5.1).

*Vectorization* is the conversion of a binary image into a series of graphical primitives, mainly line segments and arcs of circle, generically called "vectors", which are a good representation of the original graphics. Existing methods generally suffer from two major drawbacks, over-segmentation and poor geometric precision, especially at the junctions between vectors. We have worked for many years on this matter and proposed several techniques to overcome these limitations. In particular, we have defined a new method where strong variations of the curvature radius are assumed to be the break points between two primitives. The detection of extrema of curvature points is based on an original adaptation of an approach used in nonlinear control for fault-diagnosis and fault-tolerant control based on algebraic derivation. It is robust to noise [16].

*Performance evaluation* is a major concern in document analysis, and more generally in image processing, pattern recognition and computer vision. A way of approaching the problem considers a method to be evaluated as a completely separate module, which is fed with synthetic or real data. Evaluation is then carried out by comparing the results supplied by the module with some ground-truth. The performance of a segmentation method may also be evaluated according to the observed qualities of recognition steps, using the features provided by the method. This is sometimes called "goal-oriented performance evaluation".

We are actively involved in the organization of performance evaluation campaigns for symbol recognition, at national and international levels. More particularly, our project-team is leader of the Épeires project (cf. § 5.2), affiliated to the Techno-Vision program. This project aims at providing a complete environment of performance evaluation, for our own needs—as organizers—but also for the needs of any team working on symbol recognition or using recognition methods.

Performance evaluation of graphics recognition methods is related to several open scientific questions, including intricate problems such as defining simple and non-biased metrics and matching procedures between the ground-truth and the output of recognition methods, when the answer is more complex than a simple "recognized" or "not recognized" label—a good example is the evaluation of a vectorization method. Another potential problem is the generation of large sets of training or benchmarking data, using image degradation models. In this perspective we have a joint project with the Computer Center Vision at *Universitat Autònoma de Barcelona* on the characterization and evaluation of shape descriptors (cf. § 6.4).

## 3.3. Symbol Recognition and Spotting

Symbol recognition is the localization and identification of symbols in documents [38], to get natural features to be used in indexing and retrieval applications. Whereas it has ancient and solid foundations, and has proved to be mature for character recognition, for instance, symbol recognition still remains an open question when dealing with complex symbols having large variations and when symbols are embedded into the document. Our attention is focused on the weaknesses of the existing recognition methods, which make them difficult to use:

- In querying and browsing applications, it is often impossible to work with a database of reference symbols *a priori* known. It is more often the case that the user delineates an arbitrary symbol in a drawing and queries for similar symbols in the set of available documents. We therefore have to design methods allowing to recognize symbols, or at least to spot them "on the fly", without prior learning or precompilation of models.
- We are interested in coping with cases when a prior segmentation of the image is difficult, or even impossible, i.e., when it is necessary to design segmentation-free recognition methods or methods which simultaneously perform segmentation and recognition.
- Efficient methods for recognizing few symbols (less than 20 different models) are currently available. They work even when a symbol to be recognized is distorted by noise or by geometric transforms. However, they do not scale well to the recognition of a number of symbols an order of magnitude larger. Thus, there are both computational complexity issues and open questions about the discrimination power of methods chosen for recognition.

*Signatures* are often used for indexing and retrieval purposes, but most work has concentrated on text-based or image-based signatures. Nevertheless, we think that there is also room for graphics-specific signatures to achieve an efficient localization and recognition of symbols, and we currently work in two directions:

- Quick and robust symbol localization through image-based signatures: we propose to combine a feature descriptor method with a structural representation of symbols. We define a robust structural representation based on key points, which allows a quick localization of candidate symbols within documents. Each candidate is then recognized using a combination of shape descriptors.
- Structural shape signatures: direct work on the raw image data is not always necessary as, in many cases, vector data can be obtained from available CAD files or similar electronic representations, or can be captured through raster-to-vector conversion. It is therefore interesting to use signatures directly computed on such data.

When dealing with a large number of symbols, both signatures and structural recognition methods may not be powerful enough to discriminate. Combining outputs of classifiers or descriptors is one of the strategies used to improve recognition rates.

# 4. Application Domains

## 4.1. Application Domains

**Keywords:** *Documentation*, *document analysis*, *graphics*, *indexation*, *navigation*.

Our main application domain is the processing and analysis of documents—*i.e.* information produced by humans to communicate with other humans—which convey a huge amount of information in very "poor" formats: paper documents, or low-level, poorly structured digital formats such as Postscript, PDF or DXF.

We are more specifically interested in graphics-rich documents, typically technical documents containing text mixed with lots of graphics. The usual text-based indexing and retrieval methods are still of interest, but we also need additional ways of accessing the information conveyed by documents: recurring symbols, connections between textual descriptions and drawing parts, etc. Within this general application area, we work on two major kinds of document analysis applications:

- Specific documentation referring to a well-known framework of technical knowledge: a good knowledge about the type of information which has to be extracted from the documents is usually available, in terms of models of the symbols to be recognized. This is the case of architectural floor plans, like those of the European SCANPLAN project in which we participate (cf. § 7.1).
- Open documentation: few or even no strong assumptions are made on the kind of information to handle. This is typically the case of applications for browsing large sets of heterogeneous documents, when the user provides "on the fly" information about the symbols or structures he is looking for.

# 5. Software

## 5.1. Qgar Software

**Participants:** Philippe Dosch, Gérald Masini, Vitor Vasconcelos Araújo Silva.

**Overview.** Since several years, the QGAR project-team has devoted much effort to the construction of a software environment, to be able to reuse whole or part of software implemented during previous work, as well as collected experience. This environment includes three main parts:

- *QgarLib*, a library of C++ classes implementing basic graphics analysis and recognition methods,
- *QgarApps*, an applicative layer, including high-level applications (binarization, edge detection, text-graphics separation, thick-thin separation, vectorization, etc.),
- *QgarGUI*, a graphical interface to design and run applications, providing data manipulation and display capabilities.

The Qgar system is registered with the French agency for software protection (APP) and may be freely downloaded from its web site (http://www.qgar.org). The whole system is written in C++ and includes about 170,000 lines of code, including unit test procedures. A particular attention has been paid to the support of "standard" formats (PBM+, DXF, SVG), high-quality documentation, configuration facilities (using CMake), and support of Unix/Linux and Windows operating systems.

Application management is plugin-based. Each executable binary file is paired with a XML description file which is parsed when the user interface is launched: the corresponding application is then dynamically integrated into the menus of the interface, and dialog boxes to access the documentation and run the application are dynamically generated. In this way, any application may be easily coupled with a remote system based on a similar approach. Conversely, as the integration (or removal) of an application does not imply any modification of the user interface, the installation of remote applications, provided by partners for testing for example, is easy. This is particularly useful when comparing different methods performing the same task, in the context of performance evaluation, a topic which is part of our current research work, as previously mentioned.

**New results.**

Following the effort made since 2005 to improve the quality of its components, a new major version (3.0) has been released in the fall of 2007 and a bug-fixed version (3.01) has been released in August 2008. The components of these versions (QgarLib, QgarApps, QgarGUI) compile under Linux as well as under Windows, using the same scripts (based on CMake) in both cases. The whole package, including all the components, is proposed under several formats (gzipped tar archive, DEB package, Windows installer) in order to provide different easy ways to install Qgar, on most of existing platforms. The most interesting characteristics of these versions are:

- All compilation scripts are now based on CMake (instead of autoconf/automake) so that the same set of scripts can be used to compile and install the software on Linux (with compiler gcc) and Windows (with compilers MinGW and Visual Studio) platforms.
- The Qgar graphical interface has been reengineered using the graphical toolkit of Qt4 (instead of Qt3 used for the previous versions). As Qt4 is not backward compatible with Qt3, the adaptation of the source code has required a lot of work.
- The installation guide, the compilation guide, and the development documentation have been rewritten and/or updated in order to take the last modifications into account.

**Perspectives.**

After the adaptation to Qt4 and CMake, which has been very time-consuming, there is still a lot of work to be done during 2009. In particular, a lot of experimental code of the Qgar development library or belonging to the QgarApp component has to be progressively refactored either to be included into the Qgar platform or updated according to the last specifications of the platform (for those already included). As the whole Qgar software now relies on up-to-date library (Qt4) and tool (CMake), we plan to pay our attention on these integrations in order to provide a software as useful and attractive as possible, for our own needs as well as for those of the community.

## 5.2. The Épeires Environment

**Participants:** Philippe Dosch, Vincent Meslard.

Techno-Vision is a French national program to fund projects related to performance evaluation of vision algorithms in computer science. We have been leaders of the Epeires project[1] on performance evaluation of symbol spotting and recognition (2005–2007) and, as such, in charge of the scientific animation, of the creation of the information system related to the project, and of the creation of the testing data which have been used during evaluation campaigns, like the three editions of the International Contest on Symbol Recognition, organized during the last GREC workshops. In this context, we have improved the Epeires framework, a complete information system, capable of managing all required data related to performance evaluation of symbol recognition methods. It includes the management of data themselves, but also of their classification, of the automatic degradation processes, of the participant profiles, and of the available tests and result storage. This environment has been developed using the *Ruby on Rails* framework (http://www.rubyonrails.org/), and is available at the web site of the project, hosted at http://www.epeires.org.

The web site is also the location where all resources related to the project are freely available to the scientific community. In this way, users are able to declare their methods, and the related characteristics, to generate testing evaluations for specific purposes or to download existing ones, and to send and analyze their results. The same functionalities are provided to the organizers (Épeires Consortium).

We also developed a collaborative ground-truth managing software, called Picvert, coded in Java and hosted at http://gforge.inria.fr/. It is used to create, review and validate test-image labellings with respect to reference symbols (ground-truth). Its architecture is based on a client/server model connected to the information system.

The web site is now fully operational, and we continue to improve it, by adding new functionalities and by refining the existing content. It has been used to organize the third International Symbol Recognition Contest, which has been held during GREC'2007 in Curitiba, Brazil [35]. As we still extend both web site functionalities and data, we plan to use it to organize several other campaigns during 2009, and in particular for the fourth edition of International Symbol Recognition Contest, planned to be held during GREC'2009 in La Rochelle, France.

[1] http://www.epeires.org/

# 6. New Results

## 6.1. Combination of Classifiers and Shape Descriptors

**Participants:** Sabine Barrat, Santosh K.C, Bart Lamiroy, Salvatore Tabbone, Oriol Ramos Terrades, Laurent Wendling.

Combining outputs of classifiers or descriptors is one of the strategies used to improve classification rates in common classification [14]. We tackled the problem of combining classifiers within a non-Bayesian framework, considering both two-class and multi-class classifiers. A classifier is assimilated to a random variable and finding the best classifier combination is expressed as solving an optimization problem. This approach has been applied to the combination of a set of ridgelets descriptors [31].

We are also interested in combining image descriptors and text modes. We have chosen to use probabilistic graphical models, especially Bayesian networks. In fact, these models allow for combining different types of information inside a same network, and for managing missing data. We have proposed an original adaptation of such networks to the problem of visual descriptors combination for image classification and to represent weakly annotated images and semantic relations between keywords. These models can be used to classify images and automatically extend existing annotations to new images [13], [12].

In the same vein, we have started exploring a new approach for symbol representation, learning and recognition. Wa have the aim of starting to bridge the "semantic" gap between the way we can analyze and use written text and graphical representations. We are currently exploring how a closed and well-defined expression language can contribute to characterize images, how we can learn or classify images within this framework and if, in terms, this might allow interaction (e.g. for intelligent browsing and information retrieval) between full text search and images.

In the context of a collaboration with the SYMPA team (CRAN)[2], we also proposed an iterative method to select suitable features in an industrial pattern recognition context. The feature selection method is based on the analysis of indexes extracted from the lattice defined from training in relation with the Choquet integral [9]. This selection step is embedded in an iterative algorithm to discard weaker features in order to decrease the number of rules while keeping good recognition rates. The recognition step is done with a fuzzy reasoning classifier that is well adapted for this kind of application. The proposed method is quite efficient with small learning data sets because of the generalization capacity of both feature selection and recognition steps. At last a global method of feature selection and a fuzzy linguistic rule classifier have been combined and successfully applied to an industrial problem [10]. Furthermore, two new selection schemes have been defined that discards weak or decision rules by combining a set of fuzzy measures [22].

## 6.2. Scaling of Symbol Recognition Methods

**Participants:** Bart Lamiroy, Salim Jouili, Jena-Pierre Salmon, Salvatore Tabbone, Laurent Wendling.

Storing and querying high-dimensional data are important problems in designing an information retrieval system. When handling a large database, a system needs an efficient index mechanism to retrieve data by their contents. In this perspective, we are interested in methods of information retrieval in masses of documents represented with structural form [17]. When used for graphic documents, such methods are well appropriate to pattern recognition because they offer a rich framework to describe symbols of unspecified shapes and structural relations between them. We propose a hypergraph structure, extending the concept of median graph to a median set of graph for large graphs database. This extension helps to cluster graphs and allows the number of clusters to vary with database size and data characteristics. We use the minimum common supergraph to represent our clusters that are in fact the hyperedges of a hypergraph structure. This research takes place in the scientific environment of project Navidomass (Navigation In Document Masses of the call to project ANR MDCA) related to indexing large dabases of ancient cultural heritage documents.

[2] *Research Center in Automatic of Nancy.*

When we have to recognize between roughly 500 different symbols either very similar, only differing by slight details, or completely dissimilar from a visual point of view. In particular, they can even be composed of other known and significant symbols, possibly not connected. In this context, the main difficulty is the preservation of the scalability with respect to a substantial increase of the amount of data. Our contribution consists in designing a composite descriptor, robust and compact, with a low computational complexity. It is composed of smaller elementary descriptors, yielding integer or boolean values, which are thoroughly evaluated with respect to robustness and reliability. They express information like the number of small occlusions, the presence of text, the number of connected components, the presence of symmetrical extensions, full circles [36] or rectangles, etc. As the main goal is scalability, we have developped a second stage operating disambiguation on symbol candidates. We improved a pattern recognition scheme based on genetic algorithms, by integrating circular arc features and by adding the ability to take feature topology into account [27], [32].

## 6.3. On-the-fly Recognition and Symbol Spotting

**Participants:** Bart Lamiroy, Oanh Nguyen, Salvatore Tabbone.

The SYMBOLREC associated team with CVC of Barcelona (cf. § 8.2.1) also gave rise to the opportunity of continuing previously work on on-the-fly recognition [37]. This work falls within the domains of syntactical and sketch-based symbol recognition, and is related to grammatical inference. Once topological properties of symbols are expressed using an adjacency grammar, a set of local geometric invariants is produced by grammar rules which are triggered by the recognition process, in order to further disambiguate topologically similar configurations. The combination of both steps results in a very robust and efficient recognition method well-suited to user-drawn sketches. We show that the same approach can be easily adapted to the generation of adjacency grammars, or can be used as an interface for navigation and querying based on hand-drawn examples.

We also focused on approaches to search and browse symbols in all kinds of document without prior knowledge on their contents. Our objective is to build a feature vocabulary adapted to graphic documents. We propose an adaptive method for graphic symbol representation based on shape contexts to compute local descriptors in documents. This descriptor is invariant to classical geometric transforms (rotation, scaling and translation) and based on interest points. Graphic documents are represented as textual documents thanks to a visual vocabulary built from the extracted descriptors and indexed as a text document by using the vector model and an inverted file structure [18].

## 6.4. Evaluation and Benchmarking

**Participants:** Philippe Dosch, Salvatore Tabbone, Oriol Ramos-Terrades.

Since the end of 2004, our project-team is leader of the Épeires project affiliated to the Techno-Vision campaign. The objective is the construction of a complete environment for performance evaluation of symbol recognition and localization methods. This topic has gained increasing interest in the last years, as demonstrated by the creation of three international contests on symbol recognition methods [39][15]. We plan to use the same project for the organization of the fourth edition of this contest during the forthcoming GREC'2009 workshop, which will be held in La Rochelle, France. In addition, we have worked with the other Épeires partners on the definition of the related metrics and protocols required by evaluation campaigns. This also includes the development of an open source collaborative ground-truth management software for dataset labelling purpose (cf. § 5.2).

In collaboration with CVC at University of Barcelona as part of the SYMBOLREC associated team (cf. § 8.2.1), we also started a new project about characterization of shape descriptors, in order to define a "genetic map" of selected descriptors, that is to say a list of properties some families among them share. These properties must not be dataset-dependent. We hope that such a map will lead to the definition of usage profiles, so that a user facing a practical pattern recognition problem can get help in choosing the most appropriate family of descriptors. Such a protocol must be independent of datasets to be of general use. Evaluation models are easy to implement when they are dataset-driven, as they just require the computation of some recognition rates on

a given dataset. However, they do not give much information about the behavior of a descriptor on a different dataset. Our aim is the design of dataset-independent models, which is a more ambitious and a more complex task.

We are interested both in pixel-based descriptors, computed on all pixels of the shape or on a subset of these pixels (contours, or regions, for example), and in structural descriptors, computed from the components of the shape and from the relationships between them. Each descriptor must be evaluated in terms of computational complexity, of robustness to geometric transformations and image degradations, of genericity, and of separability and compactibility. The last two criteria give a measure of the discrimination power of a descriptor when the number of classes and the variability of the shapes grow.

# 7. Contracts and Grants with Industry

## 7.1. ScanPlan Project

**Participants:** Sabine Barrat, Oanh Nguyen, Salim Jouili, Salvatore Tabbone.

ScanPlan is a new project launched in December. It is an European project with the Eureka label. The aim is to develop working prototypes with document image analysis and pattern components in order to recognize raster images or vectorial files of architectural floor plans. The main challenge is to provide a new help process to the user in defining its own house plan. The features must be adapted and simplified for better ergonomy. As a result, we would like to develop a set of general document image analysis and pattern components in order to recognize raster images or vectorial files of architectural floor plans. Recognition means identify the plan components such as walls, windows, doors, furniture symbols, dimensions, etc.

The partners of the project are Anuman Interactive (France), Centro de Visio per Computador (Spain), and Icar Vision Systems (Spain).

## 7.2. Netlor Concept

**Participants:** Sabine Barrat, Salvatore Tabbone.

Netlor Concept is a French company located in Nancy, which develops web services to optimize company management and to dynamize information exchange. Until september 2008, it pays the salary of Sabine Barrat, a PhD student under a CIFRE contract, who works on objects recognition (cf. § 6.1).

# 8. Other Grants and Activities

## 8.1. National Actions

### *8.1.1. Navidomass*

**Participants:** Salim Jouili, Salvatore Tabbone.

The NAVIDOMASS project was accepted by the scientific committee of ANR in Fall 2006 and started at the beginning of 2007. It is a research proposal to the ANR call on Data Masses (ARA MDCA). The general purpose is the construction of a framework to digitally preserve and provide universal access to heritage document collections in libraries, museums and public archives. The main focus is the navigation in large databases of archives containing text, images, illustrations and schemas, through the extraction of knowledge from images of documents.

Our partners are the IMADOC group at IRISA in Rennes, Centre d'Études Supérieures de la Renaissance in Tours (CESR, UMR 6576), and the universities of La Rochelle, Tours, Rouen and Paris 5.

## 8.2. International Cooperation

### *8.2.1. CVC Barcelona*

We intensified our long-lasting scientific cooperation with the Computer Vision Center at *Universitat Autònoma de Barcelona*, including joint PhD supervisions, student, regular researcher and post-doc exchanges, collaboration in the Techno-Vision Épeires project, INRIA associated team SYMBOLREC[3], funding through PAI Picasso for joint work, joint European proposal, and joint organization of international symbol recognition contests.

We also continue our joint project on the characterization and evaluation of shape descriptors (cf. § 6.4), and organized a workshop which has been held in Nancy in december 17-19.

The work on the evaluation includes:

- Performance evaluation of symbol recognition: after the organization of three editions of the contest on symbol recognition, the framework for performance evaluation is mature enough to become an online tool for continuous evaluation of symbol recognition and segmentation methods. In collaboration with the French project EPEIRES the work will be focused to make the platform available through the web so that anyone can at anytime evaluate the performance of a given method with one of the predefined sets of images. In addition, we will also work on the development of improved methods for the automatic generation of synthetic images for the evaluation of symbol segmentation.
- Characterization of shape descriptors: with the work developed during 2007 we have already defined a complete protocol for the evaluation of shape descriptors and we have implemented an partially evaluated a set of standard descriptors with a limited set of databases (refs). During 2008, the work has continued with the implementation of an extended set of descriptors, the generation of a complete set of datasets including all kinds of descriptors and the final evaluation of all descriptors using these datasets.
- Shape-based indexing and spotting: the problem of detecting symbols in large document images is still a problem of particular interest for the SymbolRec consortium. We will continue the work according to two major lines. Firstly, as stated above, the development of performance evaluation protocols and ground truths, secondly, the proposal of signatures and indexation structures to access to large amount of data by shape indices.

### *8.2.2. SEPIA*

**Participants:** Thai Hoang Van, Salvatore Tabbone.

SEPIA, *Système d'Étude du Patrimoine des Inscriptions Anciennes au Vietnam*, is a CNRS international project with *Mica* Lab in Hanoi (Vietnam). SEPIA deals with the problem of indexing and searching for information (typically ideograms) in images of ancient Vietnamise steles. We propose a system including the following steps [29]:

- Binarization: Convert the original images of steles into binary images,
- Segmentation: Separate the regions of interest from the others,
- Description: Represent the segmented images of each ideogram by descriptors.

### *8.2.3. IDEA*

**Participants:** Benoît Naegel, Oriol Ramos Terrades, Salvatore Tabbone.

[3] http://dag.cvc.uab.es/symbolrec/

IDEA (Images of natural Disasters from robot Exploration in urban Area) is a regional programme *Ict*-Asia. Its aim is the development of an expertise about image processing and computer vision for urban natural disasters, when using a camera mounted on a patrolling robot as a mobile sensor on disaster sites. More precisely, it proposes a new research direction to make it easy to identify images and to take decision about rescue management after a natural disaster. Our partners in this project are team *Modélisation et Simulation Informatique de systèmes complexes* at *Institut de la Francophonie pour l'Informatique* of Hanoi (Vietnam), Institute of Information Technology of Hanoi, *Universiti Kuala Lumpur Malaysia*, and *Laboratoire Informatique, Image, Interaction* (L3I) at *Université de La Rochelle*.

From July 15 to September 30, Nhu Van NGUYEN, a PhD student from IFI Hanoi, stayed in Nancy and worked on characteristics extraction from natural images, in a purpose of content-based image retrieval. He experimented and compared several shape signatures.

# 9. Dissemination

## 9.1. Animation of Scientific Community

### *9.1.1. Journals*

Karl Tombre is editor in chief of the International Journal on Document Analysis and Recognition (IJDAR), member of the advisory board of Electronic Letters on Computer Vision and Image Analysis (ELCVIA), and member of the editorial board of Machine Graphics & Vision and of *Revue Africaine de la Recherche en Informatique et Mathématiques Appliquées* (ARIMA).

Salvatore Tabbone is member of the editorial board of Journal of Universal Computer Science (JUCS).

### *9.1.2. Associations*

Karl Tombre is the elected president of the International Association for Pattern Recognition (IAPR, see http://www.iapr.org/) for a two-years term from 2006 to 2008.

### *9.1.3. Other Responsibilities*

- Bart Lamiroy is elected to the scientific council of INPL.

  He is a member of *Comité de suivi de l'espace transfert*, which follows and evaluates spin-offs and start-ups resulting from research works carried out in LORIA.

  He is an active member of the Education Commission of the Information Technology Service Management Forum (itSMF) France.
- Gérald Masini is the president of the Commission of Information Technology Users (CUMI), and also head the IT Service at LORIA.
- Karl Tombre is the director of the INRIA Nancy-Grand Est Research Center. He is also the director of LORIA. His main duty is therefore to manage a large research center of about 450 persons.
- Laurent Wendling is a member of the council of LORIA and member of the administrative council of GRCE. He is also elected to the studies council (CEVU) of Université Henri Poincaré Nancy 1.
- Salvatore Tabbone and Karl Tombre are members of the administrative council of AFRIF (French Association for Pattern Recognition and Interpretation).

## 9.2. Collaborations within INRIA

Cooperations are ongoing with the team project Alien on robust features extraction [16] and with the team SYMPA (Cran) on features selection [10].

We regularly work with the IMADOC group at IRISA, a partner of our new NAVIDOMASS project (cf. § 8.1.1) on heritage documents.

## 9.3. Teaching

Most members of the QGAR project-team are university faculty members and, as such, have a statutory teaching service in their respective universities, cumulated, for several of them, with major organizational and administrative responsibilities. They have teaching positions at various institutions:

- Philippe Dosch, at Université de Nancy 2, at bachelor level.

  He is the director of studies for the bachelor degree "Administration of open source systems, networks and applications".

- Bart Lamiroy, at *Institut National Polytechnique de Lorraine/École des Mines de Nancy* (engineering school, master of engineering level).

  He heads the Department of Computer Science, and is the technical coordinator of the IPISO specialized degree.

- Benoît Naegel, at Université Henri Poincaré Nancy 1/IUT de Saint-Dié des Vosges (at bachelor level).

- Salvatore Tabbone, at Université de Nancy 2, at bachelor and master level. He also heads one of the computer science masters (M2 Miage-ACSI) of Université de Nancy 2.

- Laurent Wendling, at Université Henri Poincaré Nancy 1/ESIAL (engineering school, master of engineering level).

## 9.4. Conference and Workshop Committees

- Philippe Dosch is member of the program committee of CIFED'2008 ($10^{e}$ Colloque International Francophone sur l'Écrit et le Document, Rouen, France).

- Bart Lamiroy is member of the program committee of CIFED'2008 ($10^{e}$ Colloque International Francophone sur l'Écrit et le Document, Rouen, France) and CIDE'2008 ($11^{e}$ Colloque International sur le Document Electronique, Rouen, France) .

- Salvatore Tabbone was the general chairman of CIFED'2008 ($10^{e}$ Colloque International Francophone sur l'Écrit et le Document, Rouen, France). He is member of the program committees of CIFED'2008 ($10^{e}$ Colloque International Francophone sur l'Écrit et le Document, Rouen, France), CARI'2008 (9th African Conference on Research in Computer Science and Applied Mathematics, Rabat, Maroc), ACM-SAC'2008 (23rd ACM Symposium on Applied Computing, Fortaleza, Brazil), ICCR'2008 (2nd International Conference on Cognition and Recognition, India), ICDAR'2009 (10th International Conference on Document Analysis and Recognition, Barcelona, Spain), GREC'2009, (8th International Workshop on Graphics RECognition, La Rochelle, France), ORASIS'2009 ($12^{e}$ Congrès Francophone des Jeunes Chercheurs en Vision par Ordinateur, Trégastel, France), and TAIMA'2009 (Traitement et Analyse de l'Information : Méthodes et Applications, Hammamet, Tunisie).

- Karl Tombre was/is member of the program committee of CAIP'2009 13th International Conference on Computer Analysis of Images and Patterns (Mnster, Germany), GREC'2009 8th International Workshop on Graphics Recognition (La Rochelle, France), ICDAR'2009 (10th International Conference on Document Analysis and Recognition, Barcelona, Spain), ICPR'2008 19th International Conference on Pattern Recognition (Tampa, Florida, USA), DAS'2008 (8th International Workshop on Document Analysis Systems, Nara, Japan), RFIA'2008 ($16^{e}$ Congrès Francophone AFRIF-AFIA de Reconnaissance des Formes et Intelligence Artificielle, Amiens, France), CIFED'2008 ($10^{e}$ Colloque International Francophone sur l'Écrit et le Document, Rouen, France), CIARP'2008 (13th Iberoamerican Congress on Pattern Recognition, Havana, Cuba).

- Laurent Wendling was/is member of the program committee of IASTED VIIP'2008 (7th International Conference on Visualization, Imaging, and Image Processing, Palma de Mallorca, Spain), and CIFED'2008 ($10^{e}$ Colloque International Francophone sur l'Écrit et le Document, Rouen, France).

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