LORIA
Evaluation from January 2011 to June 2016

Team QGAR

1.1 Team QGAR

Querying Graphics through Analysis and Recognition

1.2 Synopsis

1.2.1 Team Composition

Permanents

Salvatore-Antoine Tabbone (Professor, *Université de Lorraine*), Philippe Dosch (Associate Professor, *Université de Lorraine*), Bart Lamiroy (Associate Professor, *Université de Lorraine*), Gérald Masini (Research Fellow, CNRS), Jonathan Weber (Associate Professor, *Université de Lorraine*, arrived in september 2012),

Associate members

Stéfane Paris (Associate Professor, *Université de Lorraine*), Karl Tombre (Professor, Vice-President at *Université de Lorraine* for partnerships and international affairs)

	PR	MCF	DR	CR	Total
2011	1	3			4
2016	1	3		1	5

Visiting scientist

Makoto Hasegawa (Professor, Tokyo Denki University April 2011–Dec 2012), Daniel Lopresti (Professor, Lehigh University, December 2011, July 2012, June 2013), Ricardo Torres da Silva (Professor, University Campinas, Brazil, December 2012–February 2013), Elisa Barney-Smith (Associate Professor, Boise State University, USA, October–Dec 2014 and March–July 2015)

Doctoral students

Abdessalem Bouzaieni (CIFRE XILOPIX, 2014–), Rachid Hafiane (UL, 2012–), Do Than Ha (MOET Vietnam and Europe, 2010–2013), Mehdi Felhi (CIFRE OCE, 2011–2014), Amani Boumaiza (Europe, 2010–2013), Thai Hoang (BDI PED CNRS, 2008–2012), Salim Jouili, (ANR, 2007–2011), Santosh KC (INRIA CORDI, 2008–2011)

Phd's defended	6	On-going PhD's	2

Team evolution

The team QGAR stops its research activity at the end of this year.

1.2.2 Life of the team

Several seminars are organized each year. These seminars are given by the members of the team (permanent members or PhD students) or by invited scientists.

1.2.3 Research topics

Keywords

Document analysis and recognition, image analysis, pattern recognition.

Research area and main goals

The Qgar team works on pattern recognition methods to compute useful features for image and document indexing. Our research belongs to image analysis field, and mainly to the document recognition community. The main contributions of the team are in the area of algorithms and methods for image segmentation and recognition, shape recognition with a specific focus on images of graphics-rich documents.

1.2.4 Main Achievements

Main works on pattern recognition methods have been published in leading international journals.

1.2.5 Research activities

Feature extraction and segmentation

Description As conversion from pixels to features raises a great deal of problems, our project-team have to design several algorithms and methods for noise removal, image segmentation and text detection.

Main results

- Edge noise removal: We propose different methods for denoising bilevel graphical document images by using learning dictionary based on sparse representation. Learning method starts by building a training database from corrupted images and constructing an empirically learned dictionary by using sparse representation. This dictionary can be used as a fixed dictionary to find the solution of the basis pursuit denoising problem. In addition, we provide an interesting energy noise model (the best value of the reconstruction error) which allows us to easier set the threshold required for noise removal when the model of noise is known[5] or unknown[31].

- Image segmentation: We propose a filtering method for the quasi-flat zones [19] which are image simplification operators also used as segmentation preprocessing. Our proposition achieves better filtering and requires less computation time than existing methods. Additionaly, we propose an interactive segmentation method [2] which has been compared to state-of-the-art approach on leaf segmentation and achieves good performance. Moreover, we also introduce new spatio-temporal definition of quasi-flat zones to efficiently analyze satellite time series [53]. Such definition combined with Dynamic Time Warping achieve good performance. Furthermore, we work on interactive segmentation on tactile tablets [46]. The idea is to combine component-tree based segmentation and meaningful scales to obtain a fast and non parametric segmentation method adapted to tablet specifications.

- Text detection: We investigate two research directions; one to extract text from graphical documents and the other from real scene images. For graphical documents, we propose

an original sparse representation method based on multi-learned dictionaries[30] where two sequences of learned dictionaries for the text and graphical parts respectively are defined following different sizes and non-overlapped document patches. Based on these representations, each patch in a document can be classified into the text or graphic layer by comparing its reconstruction errors. Same-sized patches in one category are then merged together to define the corresponding text or graphic parts. For natural scenes, we propose a method without learning phase. The approach is based on present a skeleton based descriptor to describe the strokes of the text candidates that compose a spatial relation graph. Then we apply the graph cuts algorithm to label the nodes of the graph as text or non-text. Finally the image is segmented after a classification step that aims to refine the results[32, 55]. In this perspective, we present a new hybrid page segmentation approach based on connected component and region analysis. Our approach is able to segment and identify lines, background(s), photo regions and multiscale text [56, 33].

- Typeface features: We have initiated a collaboration with the ANRT (*Atelier National de Recherche en Typographie*) and are developing new feature extractors that are able to describe typefaces, and extract the parameters defining an observed font from noisy scanned documents [47]. We address problems like inferring the most likely original shape from multiple noisy instances, robust curvature detection, automatic learning of human perception linked features, *etc.*

Shape descriptors

Description Shape (or symbol) recognition remains an open question when dealing with complex shapes having large variations, distorted by affine transformations and when they are embedded into the rest of the document. In any shape recognition process, before the recognition step, we need to to extract features, called usually *signatures*. Most works are concentrated on text-based or image-based signatures (popular methods are based on Bag of Features) and there is still room for graphic specific signatures to achieve efficient localization and recognition of shapes. Broadly speaking, we can group the descriptors according to their structural or statistical properties. Structural descriptors consider the structure of the shape in their definition. Graphs are data structures that best represent this type of information. In statistical descriptors the relationship between primitives is not made explicit. Therefore, statistical descriptors are feature directly computed from raw images on the pixels (or only the contours) composing the shape.

Main results

- Invariant image transformation descriptors: Polar harmonic transforms were recently proposed and have shown nice properties for image representation and pattern recognition. We proposed generic polar harmonic transforms [10] and a fast and efficient method based on the inherent recurrence relations among harmonic functions that are used in the definition of the radial and angular kernels of the transforms. The employment of these relations leads to recursive strategies for fast computation of harmonic function-based kernels [9].

- Symbol recognition is still an active field when dealing with complex shapes having large variations and distortions, structural representations or when they are embedded into the images [61]. We intensified our works on the Radon transform with a study on its robustness to white noise [14] and new descriptors robust to affine transformations and deformations [3, 39]. Radon-based invariant shape descriptors are different from the others

in the sense that Radon transform is used as an intermediate representation upon which invariant features are extracted from for the purpose of indexing/matching.

We have been focusing on extending work on spatial relation models and have used it as a basis for complex symbol description and recognition [12, 13, 58]. The method based on the spatio-structural description of a "vocabulary" of extracted visual elementary parts. The method consists of first identifying vocabulary elements and then computing spatial relations between the possible pairs of labelled vocabulary types. These are further used as a basis for building an Attributed Relational Graph that fully describes the symbol. The experiments show that this approach, used for recognition, significantly outperforms both structural and signal-based state-of-the-art methods. It has also been extended to indexing of spatial relations [44].

- Structural description: We propose to adapt the Bag of Words model into the context of graphs. In particular, we define two BoW-based methods: The Bag of Singleton Graphs and the Bag of Visual Graphs[28, 27], which create vector representations for graphs and images, respectively. The first approach generates a bag representation for objects modeled as graphs with attributes associated with their vertices and edges. The second approach creates BoW-based descriptors using graphs to model the spatial relationships between the visual words found within an image. Both methods are validated in classification tasks obtaining significant results in terms of both accuracy and execution time.

Benchmarking and performance evaluation

Description The QGar team is involved in a long-term international collaboration with Lehigh University to develop and promote a new approach to document image analysis benchmarking and performance evaluation. The Document Analysis and Exploitation platform (DAE) is a sophisticated technical environment that consists of a repository containing document images, implementations of document analysis algorithms, and the results of these algorithms when applied to data in the repository. The use of a web-services model makes it possible to set up document analysis pipelines that form the basis for reproducible protocols. Since the platform keeps track of all intermediate results, it becomes an information resource for the analysis of experimental data. The features of the platform have been extended in order to support RDF and SparQL queries [57].

Main results The current adopted methods for experimental validation essentially consist of confronting new approaches to established and commonly accepted annotated benchmark data (usually referred to as Ground Truth of Golden Standard). Results and rankings of participating approaches are generally obtained through precision and recall-like metrics. These metrics have the drawback of solely reflecting the adequacy of the participating methods to the exact interpretation context for which the benchmark was conceived. Very often, slight variations in this context can lead to significantly different results. We have already shown that in most cases, it is theoretically impossible to be sure that two compared methods actually share the same context and that using precision/recall-like metrics are fundamentally biased to that avail. We have therefore started investigating new statistical and formal metrics that consist in measuring the various degrees of agreement and disagreement of sets of methods on benchmarking data, especially when this data itself contains errors.

1.3 Scientific production and quality

1.3.1 Synthesis of publications

	2011	2012	2013	2014	2015	2016
PhD Thesis	3		1	2		
H.D.R			1			
Journal	1	7	4	9	1	2
Conference proceedings	14	17	6	7	7	
Conference proceedings (non selective)	5		1	1		
Book chapter			3	2		
Book (written)						
Book or special issue (edited)				3	2	
Patent						
General audience papers						

1.3.2 List of top journals in which we have published

IEEE Transactions on Image Processing[9, 2] (IF 3.625), Pattern Recognition[7, 6, 11, 3, 8, 15] (5 years Impact Factor 3.613), Neurocomputing[4] (5 years IF 2.292), Signal Processing[1] (5 years IF 2.36), Pattern Recognition Letters[12] (5 years IF 1.896), Image and VIsion Computing[10, 18] (5 years IF 1.68), International Journal on Document Recognition[17, 5, 13] (IF 1).

1.3.3 List of top conferences in which we have published

International Conference on Pattern Recognition ICPR, International Conference on Document Analysis and Recognition (ICDAR) [50, 49, 22, 37, 45, 44, 25, 21], Document Analysis System (DAS)[51, 24, 33, 31], Graph-Based Representations in Pattern Recognition (GBR)[43, 11, 36], Structural, Syntactic, and Statistical Pattern Recognition (SSPR)[34, 38], IEEE International Conference on Image Processing (ICIP)[41, 40, 27], International Conference Computer Analysis of Images and Patterns (CAIP)[35, 26], IEEE International Geoscience and Remote Sensing Symposium (IGARSS)[53], International Symposium on Mathematical Morphology (ISMM)[20].

1.3.4 Software

Hasegawa Makoto and Salvatore Tabbone transferred their Radon-based shape descriptor to Universal Robot, a Japanese company developing Intelligent Software based on signal processing. Bart Lamiroy transferred his circle detection technology [59] to Exameca, a French company focusing on metrology and precision engineering.

We developped a symbol spotting method [54]. The software is available on the website http://syssy.loria.fr.

1.4 The academic reputation and appeal

1.4.1 Prizes and Distinctions

Best paper award in ACM SAC in 2012 and ACM DocEng in 2013. Nominated for the best paper: ICIP 2013 (paper[27]), ICPRAM 2014 (paper[39]), DAS 2014 (paper[33]), CIFED 2014 (paper[56]).

1.4.2 Editorial and organizational activities

Bart Lamiroy is member of the editorial board of IJDAR (International Journal of Document Analysis and Recognition), he is associate editor for the Journal of Imaging Science and Technology, published by IS&T, and review editorial board member for Frontiers in Digital Humanities, Cultural Heritage Digitization speciality section. He is co-chair of DRR'2016 and DRR'2015 (Document Recognition and Retrieval XXIII and XXII, San Francisco, USA), area chair for Graphics Analysis and Recognition at ICDAR'2015 (13th International Conference on Document Analysis and Recognition, Gammarth, Tunisia - relocated to Nancy), and program co-chair and organizing chair of GREC'2015 (11th International IAPR Workshop on Graphics Recognition, Sousse, Tunisia - relocated to Nancy) He was also General Chair of GREC 2013 (10th IAPR International Workshop on Graphics Recognition, Bethlehem, PA, USA). Bart Lamiroy was PC member of 22 international and national conferences, member of the RFIA steering committee in 2016 and 2014 and organized GREC 2013 and GREC 2015.

Philippe Dosch was PC member of 4 international and national conferences. Philippe Dosch is also the integrator of the whole current LORIA activity report.

Salvatore Tabbone is member of the editorial board of JUCS (Journal of Universal Computer Science). Salvatore Tabbone was/is program co-chair of ICPRAM'2014 (3rd International Conference on Pattern Recognition Applications and Methods, Angers, France), general chair of the organizing committee of CIFED'2014 (Colloque International Francophone sur l'Ecrit et le Document, Nancy, France). Salvatore Tabbone was PC member of 32 international and national conferences.

Karl Tombre is member of the advisory board of ELCVIA (Electronic Letters on Computer Vision and Image Analysis), and of the editorial board of Machine Graphics and Vision and of *Revue Africaine de la Recherche en Informatique et Mathématiques Appliquées (ARIMA)*. He also co-edited a handbook on Document Image Analysis in 2014. Karl Tombre was the editor in chief of the International Journal on Document Analysis and Recognition (IJDAR). Karl Tombre was/is member of program committee for 9 international conferences.

Jonathan Weber was member of the organizing comittee of CIFED'2014 (Colloque International Francophone sur l'Ecrit et le Document, Nancy, France). Jonathan Weber was PC member of 7 international and national conferences.

1.4.3 Services as expert or evaluator

Bart Lamiroy is IAPR TC-10 Vice Chair since 2014 and Chair of the IAPR standing committee on Publications and Publicity. He is treasurer of the French IAPR chapter AFRIF since 2012. He served as a referee for the ANR and is a scientific expert to the French Ministry of Research and Higher Education for the CIR (Crédit Impôt Recherche). He served on 5 PhD committees (2 abroad).

Salvatore Tabbone is president of the GRCE (Groupe de Recherche en Communication Ecrite) since December 2010. Until August 31, 2012, Karl Tombre was the director of the Inria Nancy–Grand Est Research Center. Since September 1, 2012, he is vice-president of *Université de Lorraine*, in charge of partnerships and international affairs.Salvatore Tabbone participated as reviewer to 7 (3 abroad) PhD thesis committees and 2 HDR committees and as examinator for 13 PhD thesis (1 abroad) and 1 HDR. He served also as expert for funding agencies (AERES, ANR, ANRT, FNRS-Semaphore Belgium).

Karl Tombre was/is member of the HCERES evaluation committee for Université Claude Bernard Lyon 1 (2015) and for ENSTA (2016). He served on one HDR committee.

1.4.4 Collaborations

We intensified our long-lasting scientific cooperation with the Computer Vision Center at Universitat Autònoma de Barcelona (Oriol Ramos-Terrades co-advised the PhD thesis of Do Thanh Han[1]). A collaboration has been initiated with University of Campinas (Sao Paulo, Brazil) on graph matching based on bag of graphs[28, 27]. We have a collaboration with Luc Brun (co-advisor of the PhD thesis of Rachid Hafiane) from GREYC-ENSI Caen on graph indexing based on theorical aspects on graph embedding[36].

Bart Lamiroy was a visiting scientist at Lehigh University from 2010–2011, and developed subsequent strong relations with professor Daniel Lopresti who visited the QGar team in 2011, 2012 and 2013. Bart Lamiroy returned the visit in 2015. This collaboration is related to reproducible research and performance analysis in Document Image Analysis and gave rise to the DAE evaluation platform[50, 49, 51, 29, 52, 48].

A strong collaboration with Boise State University was initiated in 2014 and professor Elisa Barney Smith[5] stayed 7 months in Nancy (October–December 2014, March-July 2015). This collaboration concerns image analysis techniques for the extraction of typographic features in historical documents [47, 21]. This work is also supported by ongoing exchanges with the Atelier National de Recherche Typographique (ANRT) in Nancy.

A collaboration has been initiated with Erchan Aptoula (Okan University, Turkey) on some theoretical aspects of mathematical morphology for color or multiband images [60]. We also work with François Petitjean (Monash University, Australia) on simplification, segmentation and classification of Satellite Image Time Series [16]. Moreover, we work on segmentation issues on various types of image with Manuel Grand-Brochier (Université d'Auvergne) [2].

1.4.5 External support and funding

- European project with the Eureka label SCANPLAN (2009-12)
- European project with the CHIST-ERA project AMIS (2016-19)
- PEPS CNRS SIGBaM (2012-13, leader), PICS DIA-TRIBE(2015-2017, leader), PHC Volubilis (2010-12), Chercheur d'excellence program by the Région Lorraine (2015), MSH Lorraine pre-operation funding (2015), ANR DIA-Tribe (2015) submitted and passed phase 1, received excellent reviews in phase 2 but remained unfunded.
- Industrial contracts: OCE Canon (2011-2013), Xilopix (2014-2017), Exameca (2014)

1.5 Involvement with social, economic and cultural environment

Bart Lamiroy recurrently participated in *Fête de la Science* events in 2013, 2014 and 2015.

1.6 The involvement in training through research

Bart Lamiroy is chair of the Computer Science department of the École des Mines de Nancy.

Philippe Dosch heads one of the professional bachelor in computer science of *Université de Lorraine*.

Salvatore Tabbone is the director of UFR *Mathématiques et Informatique* of *Université de Lorraine* (see `http://www.univ-lorraine.fr/content/ufr-mathematiques-et-informatique`) and heads one of the computer science masters (M2 Miage-ACSI).

Jonathan Weber is head of the MMI department (Web and Multimedia) of *IUT de Saint-Dié*. He is also Vice-President of the MMI department Head Association, in charge of communication on social networks.

Articles in International Peer-Reviewed Journal

[1] T. S. Do Thanh Ha, Ramos-Terrades, "Sparse Representation over Learned Dictionary for Symbol Recognition (to appear)", *Signal Processing*, 2016.

[2] M. Grand-Brochier, A. Vacavant, G. Cerutti, C. Kurtz, J. Weber, L. Tougne, "Tree leaves extraction in natural images: Comparative study of pre-processing tools and segmentation methods", *IEEE Transactions on Image Processing 24*, 5, 2015, p. 1549–1560, https://hal.archives-ouvertes.fr/hal-01176699.

[3] M. Hasegawa, S. Tabbone, "Amplitude-only log Radon transform for geometric invariant shape descriptor", *Pattern Recognition 47*, 2, 2014, p. 643–658, https://hal.archives-ouvertes.fr/hal-01098678.

[4] M. Hasegawa, S. Tabbone, "Histogram of Radon transform with angle correlation matrix for distortion invariant shape descriptor", *Neurocomputing 173*, part 1, 2016, https://hal.archives-ouvertes.fr/hal-01254923.

[5] T. V. Hoang, E. H. Barney Smith, S. Tabbone, "Sparsity-based edge noise removal from bilevel graphical document images", *International Journal on Document Analysis and Recognition 17*, 2, June 2014, p. 161–179, https://hal.inria.fr/hal-00852418.

[6] T. V. Hoang, S. Tabbone, "Invariant pattern recognition using the RFM descriptor", *Pattern Recognition 45*, 1, January 2012, p. 271–284, https://hal.inria.fr/inria-00614835.

[7] T. V. Hoang, S. Tabbone, "The generalization of the R-transform for invariant pattern representation", *Pattern Recognition*, January 2012, https://hal.inria.fr/inria-00637631.

[8] T. V. Hoang, S. Tabbone, "Errata and comments on "Generic orthogonal moments: Jacobi–Fourier moments for invariant image description"", *Pattern Recognition 46*, 11, April 2013, p. 3148–3155, https://hal.inria.fr/hal-00820279.

[9] T. V. Hoang, S. Tabbone, "Fast generic polar harmonic transforms", *IEEE Transactions on Image Processing 23*, 7, May 2014, p. 2961 – 2971, https://hal.inria.fr/hal-01083716.

[10] T. V. Hoang, S. Tabbone, "Generic polar harmonic transforms for invariant image representation", *Image and Vision Computing 32*, 8, 2014, p. 497 – 509, https://hal.inria.fr/hal-01083722.

[11] S. Jouili, S. Tabbone, "Hypergraph-based image retrieval for graph-based representation", *Pattern Recognition 45*, 11, 2012, p. 4054–4068, https://hal.archives-ouvertes.fr/hal-00764616.

[12] S. K.C., B. Lamiroy, L. Wendling, "Symbol Recognition using Spatial Relations", *Pattern Recognition Letters 33*, 3, February 2012, p. 331–341, https://hal.inria.fr/inria-00626996.

[13] S. K.C., B. Lamiroy, L. Wendling, "Integrating Vocabulary Clustering with Spatial Relations for Symbol Recognition", *International Journal on Document Analysis and Recognition*, May 2013, https://hal.inria.fr/hal-00824521.

[14] N. Nacereddine, S. Tabbone, D. Ziou, "Robustness of Radon transform to white additive noise: ggeneral case study", *Electronics Letters 50*, 15, 2014, p. 1063 – 1065, https://hal.archives-ouvertes.fr/hal-01111246.

[15] N. Nacereddine, S. Tabbone, D. Ziou, "Similarity transformation parameters recovery based on Radon transform. Application in image registration and object recognition", *Pattern Recognition 48*, 7, 2015, https://hal.archives-ouvertes.fr/hal-01254921.

[16] F. Petitjean, J. Weber, "Efficient Satellite Image Time Series Analysis Under Time Warping", *IEEE Geoscience and Remote Sensing Letters 11*, 6, June 2014, p. 1143 – 1147, https://hal.inria.fr/hal-00940767.

[17] M. Visani, O. Ramos-Terrades, S. Tabbone, "A protocol to characterize the descriptive power and the complementarity of shape descriptors", *International Journal on Document Analysis and Recognition 14*, 1, 2011, p. 87–100, https://hal.inria.fr/inria-00580311.

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[19] J. Weber, S. Lefèvre, "Fast Quasi-Flat Zones Filtering Using Area Threshold and Region Merging", *Journal of Visual Communication and Image Representation 24*, 3, 2013, p. 397–409, https://hal.archives-ouvertes.fr/hal-00763484.

Major International Conferences

[20] E. Aptoula, J. Weber, S. Lefèvre, "Vectorial Quasi-flat Zones for Color Image Simplification", *in : International Symposium on Mathematical Morphology, ISMM 2013*, *Lecture Notes in Computer Science*, *7883*, Springer Berlin Heidelberg, p. 231–242, Uppsala, Sweden, 2013, https://hal.archives-ouvertes.fr/hal-00905178.

[21] E. H. Barney Smith, B. Lamiroy, "Effects of Clustering Algorithms on Typographic Reconstruction", *in : 13th International Conference on Document Analysis and Recognition*, Nancy, France, August 2015, https://hal.archives-ouvertes.fr/hal-01154603.

[22] A. Boumaiza, S. Tabbone, "A Novel Approach for Graphics Recognition based on Galois lattice and Bag of Words representation", *in : 10th International Conference on Document Analysis and Recognition - ICDAR 2011*, ICDAR (editor), *11th International Conference on Document Analysis and Recognition - ICDAR 2011 - Proceedings*, IEEE, p. 829–833, Pekin, China, September 2011, https://hal.inria.fr/hal-00658235.

[23] A. Boumaiza, S. Tabbone, "Impact of a Codebook Filtering Step on a Galois Lattice Structure for Graphics Recognition", *in : 21st International Conference on Pattern Recognition*, p. 4, Tsukuba International Congress Center, Japan, November 2012. 4, https://hal.archives-ouvertes.fr/hal-00759516.

[24] A. Boumaiza, S. Tabbone, "Symbol Recognition using a Galois Lattice of Frequent Graphical Patterns", *in : 10th IAPR International Workshop on Document Analysis Systems (DAS)*, *IEEE*, Gold Coast, Queensland, Australia, March 2012, https://hal.inria.fr/hal-00658255.

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[28] F. Brandao Da Silva, S. Tabbone, R. Da Silva Torres, "BoG: A New Approach for Graph Matching", *in : international conference on pattern recognition (ICPR 2014)*, p. 82 – 87, Stockholm, Sweden, August 2014, https://hal.archives-ouvertes.fr/hal-01098679.

[29] J. Chen, D. Lopresti, B. Lamiroy, "A Real-World Noisy Unstructured Handwritten Notebook Corpus for Document Image Analysis Research", *in : Joint Workshop on Multilingual OCR and Analytics for Noisy Unstructured Text Data - (J-MOCR-AND 2011)*, *Proceedings of the 2011 Joint Workshop on Multilingual OCR and Analytics for Noisy Unstructured Text Data*, IAPR, ACM, Beijing, China, September 2011. ISBN: 978-1-4503-0685-0, https://hal.inria.fr/inria-00627844.

[30] T. H. Do, S. Tabbone, O. Ramos Terrades, "Text/graphic separation using a sparse representation with multi-learned dictionaries", *in : 21st International Conference on Pattern Recognition - ICPR 2012*, Tsukuba, Japan, November 2012, https://hal.inria.fr/hal-00759554.

[31] T. H. Do, S. Tabbone, O. Ramos Terrades, "Spotting Symbol Using Sparsity over Learned Dictionary of Local Descriptors", *in : 11th IAPR International Workshop on Document Analysis Systems (DAS)*, Tours, France, April 2014, https://hal.archives-ouvertes.fr/hal-01098684.

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[33] M. Felhi, S. Tabbone, M.-V. Ortiz-Segovia, "Multiscale Stroke-Based Page Segmentation Approach", *in : 11th IAPR International Workshop on Document Analysis Systems (DAS)*, Tours, France, April 2014, https://hal.archives-ouvertes.fr/hal-01098683.

[34] B. Gaüzère, H. Makoto, L. Brun, S. Tabbone, "Implicit and Explicit Graph Embedding: Comparison of both Approaches on Chemoinformatics Applications", *in : Joint IAPR International Workshop, SSPR & SPR 2012*, G. Gimel'farb (editor), *Lecture Notes in Computer Science*, *7626*, Springer, p. 510–518, Hiroshima, Japan, November 2012, https://hal.archives-ouvertes.fr/hal-00768654.

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[40] T. V. Hoang, E. H. Barney Smith, S. Tabbone, "Edge noise removal in bilevel graphical document images using sparse representation", *in : IEEE International Conference on Image Processing - ICIP'2011*, IEEE, p. 3549 – 3552, Brussels, Belgium, September 2011, https://hal.inria.fr/inria-00593510.

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A Team QGAR

Appendix (HCERES mandatory requirement)

Software

Hasegawa Makoto and Salvatore Tabbone transferred their Radon-based shape descriptor to Universal Robot, a Japanese company developing Intelligent Software based on signal processing. Bart Lamiroy transferred his circle detection technology [100] to Exameca, a French company focusing on metrology and precision engineering. We developped a symbol spotting method [82]. The software is available on the website http://syssy.loria.fr.

Academic appeal and reputation indicators

Prizes and Distinctions

Best paper award in ACM SAC in 2012 and ACM DocEng in 2013. Nominated for the best paper: ICIP 2013 (paper[40]), ICPRAM 2014 (paper[59]), DAS 2014 (paper[52]), CIFED 2014 (paper[88]).

Editorial and organizational activities

Philippe Dosch was PC member of 4 international and national conferences. Philippe Dosch is also the integrator of the whole current LORIA activity report.

Bart Lamiroy is member of the editorial board of IJDAR (International Journal of Document Analysis and Recognition), he is associate editor for the Journal of Imaging Science and Technology, published by IS&T, and review editorial board member for Frontiers in Digital Humanities, Cultural Heritage Digitization speciality section. He is co-chair of DRR'2016 and DRR'2015 (Document Recognition and Retrieval XXIII and XXII, San Francisco, USA), area chair for Graphics Analysis and Recognition at ICDAR'2015 (13th International Conference on Document Analysis and Recognition, Gammarth, Tunisia - relocated to Nancy), and program co-chair and organizing chair of GREC'2015 (11th International IAPR Workshop on Graphics Recognition, Sousse, Tunisia - relocated to Nancy) He was also General Chair of GREC 2013 (10th IAPR International Workshop on Graphics Recognition, Bethlehem, PA, USA). Bart Lamiroy was PC member of 22 international and national conferences, member of the RFIA steering committee in 2016 and 2014 and organized GREC 2013 and GREC 2015.

Salvatore Tabbone is member of the editorial board of JUCS (Journal of Universal Computer Science).Salvatore Tabbone was/is program co-chair of ICPRAM'2014 (3rd International Conference on Pattern Recognition Applications and Methods, Angers, France), general chair of the organizing committee of CIFED'2014 (Colloque International Francophone sur l'Ecrit et le Document, Nancy, France). Salvatore Tabbone was PC member of 32 international and national conferences.

Karl Tombre is member of the advisory board of ELCVIA (Electronic Letters on Computer Vision and Image Analysis), and of the editorial board of Machine Graphics and Vision and of *Revue Africaine de la Recherche en Informatique et Mathématiques Appliquées (ARIMA)*. He also co-edited a handbook on Document Image Analysis in 2014. Karl Tombre was the editor

in chief of the International Journal on Document Analysis and Recognition (IJDAR). Karl Tombre was/is member of program committee for 9 international conferences.

Jonathan Weber was member of the organizing comittee of CIFED'2014 (Colloque International Francophone sur l'Ecrit et le Document, Nancy, France). Jonathan Weber was PC member of 7 international and national conferences.

Services as expert or evaluator

Bart Lamiroy is IAPR Vice Chair since 2014 and Chair of the IAPR standing committee on Publications and Publicity. He is treasurer of the French IAPR chapter AFRIF since 2012. He served as a referee for the ANR and is a scientific expert to the French Ministry of Research and Higher Education for the CIR (Crédit Impôt Recherche). He served on 5 PhD committees (2 abroad).

Salvatore Tabbone is president of the GRCE (Groupe de Recherche en Communication Ecrite) since December 2010. Until August 31, 2012, Karl Tombre was the director of the Inria Nancy–Grand Est Research Center. Since September 1, 2012, he is vice-president of *Université de Lorraine*, in charge of partnerships and international affairs.

Salvatore Tabbone participated as reviewer to 7 (3 abroad) PhD thesis committees and 2 HDR committees and as examinator for 13 PhD thesis (1 abroad) and 1 HDR. He served also as expert for funding agencies (AERES, ANR, ANRT, FNRS-Semaphore Belgium).

Karl Tombre was/is member of the HCERES evaluation committee for Université Claude Bernard Lyon 1 (2015) and for ENSTA (2016). He served on one HDR committee.

External support and funding

- European project with the Eureka label SCANPLAN (2009-12)
- PEPS CNRS SIGBaM (2012-13, leader), PICS DIA-TRIBE(2015-2017, leader), PHC Volubilis (2010-12), Chercheur d'excellence program by the Région Lorraine (2015), MSH Lorraine pre-operation funding (2015), ANR DIA-Tribe (2015) submitted and passed phase 1, received excellent reviews in phase 2 but remained unfunded.
- Industrial contracts: OCE Canon (2011-2013), Xilopix (2014-2017), Exameca (2014)

Products intended for social, economic and cultural stakeholders

Bart Lamiroy recurrently participated in *Fête de la Science* events in 2013, 2014 and 2015.

Publications

Doctoral Dissertations

[1] A. Boumaiza, *Reconnaissance et localisation de symboles dans les documents graphiques: approches basées sur le treillis de concepts*, Theses, Université de Lorraine, May 2013.

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[7] K. Santosh, *Graphics Recognition using Spatial Relations and Shape Analysis*, Theses, Institut Polytechnique de Lorraine, November 2011.

[8] J. Weber, *Interactive morphological segmentation for video mining*, Theses, Université de Strasbourg, September 2011, https://tel.archives-ouvertes.fr/tel-00643585.

Articles in International Peer-Reviewed Journal

[9] T. S. Do Thanh Ha, Ramos-Terrades, "Sparse Representation over Learned Dictionary for Symbol Recognition (to appear)", *Signal Processing*, 2016.

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B Team QGAR

SWOT

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B.0.3 Critère 3 : Interaction avec l'environnement social économique et culturel

B.0.4 Critère 4 : Organisation et vie de l'entité

B.0.5 Critère 5 : Implication dans la formation par la recherche

B.0.6 Autres

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B.0.17 Critère 5 : Implication dans la formation par la recherche

B.0.18 Autres

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B.0.21 Critère 3 : Interaction avec l'environnement social économique et culturel

B.0.22 Critère 4 : Organisation et vie de l'entité

B.0.23 Critère 5 : Implication dans la formation par la recherche

B.0.24 Autres