# A - Complementary information: details about the project

**Title**: Semantic Object Detection and Segmentation Using Deep Learning

**Abstract**: the successful applications of artificial intelligence (AI) in recent years in various fields such as AI medical treatment, city security, face recognition, trimming entertainment and automatic driving have attracted extensive attention from countries all around the world. For example, in May 2016, the White House of the United States published the white paper “Preparing for the Future of Artificial Intelligence”; the United Kingdom issued “Artificial Intelligence: Opportunities and Impacts for Future Decision Making” in December 2016; France formulated in April 2017 “National Artificial Intelligence Strategy and Germany promulgated the country’s first law on autonomous driving in May 2017. In addition, Artificial Intelligence was repeatedly mentioned in the “Government Work Report” at the 2017 China Conference. More recently, the "AI for Humanity" summit held in Paris (March 2018) demonstrates the importance of AI in the next generation systems.

Object detection and semantic segmentation are the two interleaving and significant research topics of artificial intelligence. The main task is to accurately locate and detect all objects in an image or video sequence as well as semantically segment the detected objects in pixel level. Object detection and semantic segmentation performance plays a decisive role in the success of artificial intelligence because they are the basis of high-level computer vision applications.

Recent algorithms have made a breakthrough achievement in this field such as Faster R-CNN and Mask R-CNN. Nevertheless there are some open questions to be resolved. First, current supervised learning algorithms usually require a lot of labeled data to train the convolutional neural network (CNN) on the condition that the test and training data obey the same distribution. Furthermore, the convolutional neural network cannot fully learn the semantic feature of objects in labeled training data, which result in the result of semantic segmentation greatly different from Ground-Truth especially in objects boundary in the testing process. However, the clear and accurate segmentation of object boundaries in object detection and semantic segmentation is an important prerequisite for computer vision high-level applications such as AI medical treatment and automatic driving. Building on the previous studies conducted within our research team [The01, The07, RICL1, RICL5, CICL1], the present PhD project aims to investigate the information propagation in neural networks and develop new algorithms that are able to fuse high-level and low-level semantic features to boost information flow in feature hierarchy.

**Keywords**: Saliency analysis and detection, object detection, semantic image segmentation, deep learning

# B - Complementary information: resume of the supervisor

## I - Summary of research activities

### I.1. Research activities

My research focuses on the analysis and interpretation of digital images. In this context, we are interested in analyzing the images based on the texture and on the shape of objects. Our goals are then to find new algorithms or adapt existing algorithms to provide the most appropriate solutions. The various applications of our research work are: segmentation/classification, fusion of multi-temporal images and/or multi-sensor, image registration, pattern recognition, image indexing, saliency detection, semantic segmentation in image or in video sequence...

## I.2. International partnership

International collaboration and international mobility:

1. Welcomed a PhD candidate from Institut Polytechnique de Yamoussoukro (Ivory Coast, 2018), 6 months.
2. Guest Professor at Zhejiang University of Technology (China, 2017), one week.
3. Responsible of a Tassili SCCIBOV project: a French and Algeria joint program (2011-20158)
4. Guest Professor University of Gaston Berger de Saint-Louis (Senegal, since 2013) : two weeks each
5. Co-supervision of a PhD at the University of Sidi Bel Abbes in Algeria
6. Visited Peking University of Shenzhen in China (one day visit in 2012)
7. Guest Professor at Shandong University (China, 2011 and 2012), two weeks each.
8. Welcomed a PhD candidate from University of Rio de Cuarto in Argentina within the ARFITEC program (2010), three months.
9. Welcomed PhD candidates from the University of Sidi Bel Abbes in Algeria (one or five months 2012-2015).

## I.3. Expertise, reviewer and event organization

### *I.3.1 National and international expertise*

- Expertise of applications submitted to ANR in France
- Expertise of applications submitted to "Conseil de recherches en sciences naturelles et en génie du Canada (CRSNG)"

### *I.3.2 Reviewer for journals*

- African Conference on Research in Computer Science and Applied Mathematics (CARI)
- IEEE International Conference on Image Processing (ICIP)
- IEEE International Geoscience and Remote Sensing Symposium (IGARSS)
- European Signal Processing Conference (EUSIPCO)
- EURASIP Journal on Advances in Signal Processing)
- Springer Signal, Image and Video Processing
- IEEE Transactions on Geoscience and Remote Sensing (TGRS)
- IEEE Transactions on Image Processing (TIP)
- IEEE Transactions on Broadcasting Technology Society,
- The Institution of Engineering and Technology Image Processing (IET-IPR)

### *I.3.3 Organization of workshops and conferences*

- TPC of International conference on High Technology for Sustainable Development, held at Sofia in Bulgaria, 11 - 14 June 2018
- Area chair of International Conference on Computer Vision and Image Processing (CVIP) organized by the Indian Institute of Technology Roorkee, 2017 and 2018
- TPC of International conference on High Technology for Sustainable Development, held at Sofia in Bulgaria, 11 - 14 June 2018
- TCP and co-chair for "Mediterranean Conference on Information & Communication Technologies'2015 (MedICT 2015), Saïdia, Morocco
- TCP for "13th IEEE international conference on communication technology (IEEE ICCT2011)", Jinan, China
- Organizing committee of the "Third International Workshop on Cross-Layer Design (IWCLD 2011)", INSA de Rennes, France.

## II – Publications (selected papers linked to the project)

### II.1. International journals

[RICL1] Haijun Lei, Wenbin Zou, Hai Xie, Kidiyo Kpalma, Nikos Komodakis, Hierarchical Saliency Detection via Probabilistic Object Boundaries, Int. J. Patt. Recogn. Artif. Intell. (IJPRAI), http://dx.doi.org/10.1142/S0218001417550102, 2016, **[IF=0.994]**

[RICL2] Amina Belalia, Kamel Belloulata and Kidiyo Kpalma, Region-based image retrieval in the compressed domain using shape-adaptive DCT , Multimedia Tools and Applications, Springer Verlag, 2015, doi:10.1007/s11042-015-3026-2, **[IF=1.53]**

[RICL3] Wenbin Zou, Zhi Liu, Kidiyo Kpalma, Joseph Ronsin, Yong Zhao and Nikos Komodakis, Unsupervised Joint Salient Region Detection and Object Segmentation, IEEE Transactions on Image Processing, Vol. 24 , No. 11, 2015, doi:10.1109/TIP.2015.2456497, **[IF=4.828]**

[RICL4] Weizhi Lu, Jinglin Zhang, Kidiyo Kpalma, Joseph Ronsin. Efficient Visual Tracking via Low-Complexity Sparse Representation. EURASIP Journal on Advances in Signal Processing, SpringerOpen, 2015, 16 p, **[IF=1.961]**

[RICL5] Wenbin Zou, Cong Bai, Kidiyo Kpalma and Joseph Ronsin, Online Glocal Transfer for Automatic Figure-ground Segmentation, IEEE TIP, (2014), **[IF=3.199]**.

[RICL6] Miloud Chikr El-Mezouar, Kidiyo Kpalma, Nasreddine Taleb, and Joseph Ronsin, A Pan-sharpening Based on the Non-Subsampled Contourlet Transform: Application to Worldview-2 imagery, IEEE JSTARS, (2014), **[IF=2.874]**

[RICL7] Zou, W.; Kpalma, K.; Ronsin, J., Automatic foreground extraction via joint CRF and online learning, Electronics Letters, 49, (18), p.1140-1142, DOI:10.1049/el.2013.2100, (2013), **[IF=1.038].**

[RICL8] Cong Bai, Wenbin Zou, Kidiyo Kpalma, Joseph Ronsin, Efficient color texture image retrieval by combination of color and texture features in wavelet domain, Electronics Letters, 48, 1463-1465 (2012), **[IF=1.038].**

### II.2. International conferences

[CICL1] Qiong Wang, Lu Zhang and K. Kpalma, Fast filtering-based temporal saliency detection using Minimum Barrier Distance, 2017 IEEE International Conference on Multimedia & Expo Workshops (ICMEW), Hong Kong, 2017, pp. 232-237. doi: 10.1109/ICMEW.2017.8026330

[CICL2] Cong Bai, Jia-nan Chen, Jinglin Zhang, Kidiyo Kpalma, and Joseph Ronsin, Sparse representation based histogram in color texture retrieval, Advances in Multimedia Information Processing - PCM 2016, 17th Pacific-Rim Conf. on Multimedia, Xi´an, China, September 15-16, 2016, Proc., Part I, LNCS, Vol. 9916 (2016), Editors: Enqing Chen, Yihong Gong, Yun Tie, 2016

[CICL3] Dahi Ilias, Chikr El-Mezouar Miloud Taleb Nasreddine and KPALMA Kidiyo, Abandoned object detection using blind motion history analysis, SCCIBOV 2015, Sidi Bel Abbès, Algerie, Dec. 2015

[CICL4] Julien Gosseaume, Kidiyo Kpalma and Joseph Ronsin, SCOTTish: Toward an Optimal Concealment Algorithm, SCCIBOV 2015, Sidi Bel Abbès, Algerie, 2015

## II.4. PhD supervising (2005-2018)

### *II.4.1 Running PhD thesis*

[The01] Détection de saillance pour la segmentation sémantique de l'image pour la recherche d'image basée contenu.
Name: Qiong WANG
Started : oct. 2015 Date of defence: mars 2019 % Supervising rate: 50%
Co-supervisors : Lu ZHANG (50%)

[The02] Détection de trait de côte à partir d'images THRS: Cas du littoral sénégalais.
Name : Seynabou TOURE
Started : oct. 2013 Date of defence: Dec. 2018 % Supervising rate: 30%
Co-supervisors: Amadou MAIGA (30%) et Oumar DIOP (40%)

### *II.4.2 Defended PhD thesis*

[The03] Reconnaissance de visage et analyse de micro-expressions du visage.
Name : Hua LU
Started : oct. 2014 Defended: 05/04/2018 % Supervising rate: 70%
Co-supervisors: Joseph RONSIN (30%)

[The04] *Algorithme de génération de trames de Mimétisme d'Environnement dans les Domaines de l'Imagerie Visible (MEDIV)*
Name : *Julien Gosseaume*
Started : *oct. 2012* Defended: *2015* *Supervising rate*: *75%*
Co-supervisors: *Joseph Ronsin (25%)*

[The05] *Extraction de contours multi-résolution par les transformées géométriques pour le mosaïcage d'images médicales*
Name : *Abdelkrim GHAZ*
Started : *oct. 2011* Defended: 26/09/*2017* *Supervising rate*s: *50%*
Co-supervisors: *Abdennacer BOUNOUA (50%)*

[The06] *Algorithme de suivi de personnes dans une scène vidéo dans un contexte multi-camera*
Name : Weizhi LU
Started : déc. 2010 Defended: 16/07/2014 Supervising rate: 50%
Co-supervisors: Joseph Ronsin (50%)

[The07] *Segmentation pour une approche sémantique en représentation d'images pour le codage*
Name : *Wenbin ZOU*
Started : *sept. 2010* Defended: 13/03/*2014* *Supervising rate*: *50%*
Co-supervisors: *Joseph Ronsin (50%)*

[The08] *Analyse d'images compressées pour l'interprétation et l'indexation de leur contenu*
Name : *Cong Bai*
Started : *sept. 2009* Defended: 21/02/*2013* *Supervising rate*: *70%*
Co-supervisors: *Joseph Ronsin (30%)*

[The09] *Fusion d'images en télédétection satellitaire*
Name : *Miloud Chikr El Mezouar*
Started : *sept. 2010* Defended: 10/12/*2012* *Supervising rate*: *30%*
Co-supervisors: *Joseph Ronsin (30%) et Nasreddine Taleb (70%)*

[The10] *Fusion multiniveau pour la classif. d'images de télédétection à très haute résolution spatiale*
Name : *Ahsan Ursani*
Started : *sept. 2005* Defended: *04 nov. 2008* *Supervising rate*: *70%*
Co-supervisors: *Joseph Ronsin (30%)*

[The11] *Extraction d'attributs et mesures de similarité basées sur la forme*
Name : *Mingqiang Yang*
Started : *sept. 2005* Defended: *03 juil. 2008* *Supervising rate*: *70%*
Co-supervisors: Joseph Ronsin (30%)

# C - Some information about the co-supervisor

Dr **Lu ZHANG** is an associate professor at the National Institute of Applied Sciences (INSA) of Rennes, France. She is also a member of the Institute of Electronics and Telecommunications of Rennes (IETR), UMR CNRS 6164. She received the M.S. degree from Shanghai Jiaotong University in 2007. Then she participated in the Engineering Leadership Program (ELP) in National Instruments (NI) at Shanghai for two years. From October 2009 to November 2012, she was a PhD student at the University of Angers, and at laboratories LISA (renamed as LARIS now) and IRCCyN (renamed as LS2N now) in France. Her thesis topic was “Numerical observers for the objective quality assessment of medical images”. Then she worked on the Quality of Experience (QoE) in Telemedicine as a research engineer before she joined INSA and IETR in September 2013.

Her PhD thesis was awarded (in french, “prix de thèse”) by IEEE France Section, SFGBM, AGBM and GdR CNRS-Inserm Stic-Santé.

Since 2010, Dr. Lu ZHANG is the co-author of 7 international journal papers, 26 international conference papers and 5 french conference papers. She co-supervised 6 PhD students since 2015, one of them has already got her PhD degree in February 2018. Dr. Lu ZHANG became a member of the Video Quality Experts Group (VQEG) in 2013. She was an invited speaker at the 6th Qualinet General Meeting. She was invited to give seminars by several chinese universities or research institutes several times. She co-chaired the special session on “Quality Assessment for Medical Imaging Applications” in QoMEX 2018. She is the project leader of an ANR (France National Agency for Research) ASTRID (Specific Support for Defence Research Projects and Innovation) project from 2018 to 2020.

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