agence d'évaluation de la recherche
et de l'enseignement supérieur

Department for the evaluation of research units

AERES report on unit:

Center for Visual Computing

CVC

Under the supervision of the following institutions and research bodies:

École Centrale Paris

February 2014

agence d'évaluation de la recherche
et de l'enseignement supérieur

Department for the evaluation of research units

On behalf of AERES, pursuant to the Decree of 3 november 2006[1]*,*

- Mr. Didier HOUSSIN, president
- Mr. Pierre GLAUDES, head of the evaluation of research units department

On behalf of the expert committee,

- Mr Philippe CARRE, chair of the committee

[1] The AERES President "signs [...], the evaluation reports, [...] countersigned for each department by the director concerned" (Article 9, paragraph 3 of the Decree n ° 2006-1334 of 3 November 2006, as amended).

Evaluation report

This report is the result of the evaluation by the experts committee, the composition of which is specified below. The assessments contained herein are the expression of an independent and collegial deliberation of the committee.

Unit name:	Center for Visual Computing
Unit acronym:	CVC
Label requested:	UR
Present no.:	
Name of Director (2013-2014):	Mr Nikos PARAGIOS
Name of Project Leader (2015-2019):	Mr Nikos PARAGIOS

Expert committee members

Chair:	Mr Philippe CARRE, Université de Poitiers
Expert:	Mr Ivan LAPTEV , INRIA

Scientific delegate representing the AERES:

Mr Jean-Marc CHASSERY

Representative(s) of the unit's supervising institutions and bodies:

Ms Estelle IACONA, École Centrale de Paris

1 • Introduction

History and geographical location of the unit

The Center for Visual Computing (CVC) unit belongs to the École Centrale Paris School. The overall interest of the CVC is Machine Learning, Computer Vision and Medical Imaging. The CVC has been recently created (2011) and has close ties to the Inria Center Saclay-Île-de-France.

Management team

The committee has thus evaluated a fairly recently formed unit. It has not been made aware of previous scientific evaluations and conclusions. Thus, the capacity of the unit to implement external recommendations could not be mesured.

This new unit is managed by one director.

AERES nomenclature

ST6 Sciences et technologies de l'information et de la communication

ST1 Mathématiques

SVE1_LS5 Neurosciences

Unit workforce

Unit workforce	Number as at 30/06/2013	Number as at 01/01/2015
N1: Permanent professors and similar positions	1	3
N2: Permanent researchers from Institutions and similar positions		1
N3: Other permanent staff (without research duties)	1	1
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)	4,25	1,25
N5: Other researchers from Institutions (Emeritus Research Director, Postdoctoral students, visitors, etc.)		
N6: Other contractual staff (without research duties)	1	1
TOTAL N1 to N6	**7,25**	**7,25**

Unit workforce	Number as at 30/06/2013	Number as at 01/01/2015
Doctoral students	10	
Theses defended	18	
Postdoctoral students having spent at least 12 months in the unit	2	
Number of Research Supervisor Qualifications (HDR) taken		
Qualified research supervisors (with an HDR) or similar positions	1	3

2 • Overall assessment of the unit

The Center for Visual Computing is a small and recently created unit at the Ecole Centrale de Paris, with a strong connection to the Inria Center Saclay-Île-de-France thanks to the INRIA GALEN project. The GALEN forms a part of CVC and has been recently evaluated by INRIA as a future joint team project.

The objective of the unit is to develop a high standard international center for Machine Learning, Computer Vision and Medical Image Analysis. The unit targets several central problems in computer vision (Object detection, Pose estimation, Action classification, Semantic segmentation) and medical imaging (Motion estimation, Image registration and Image segmentation). It studies graphical models as a generic tool for formulating and addressing the above problems. The unit has made strong scientific contributions to all three research axes, ranging from structured output prediction and weakly-/unsupervised learning in machine learning to scale-invariant features and pose estimation in computer vision as well as deformable registration in medical image analysis. The unit also addresses a set of practical applications within medical image analysis and has a record of successful technology transer to the industry.

The international nature of this young unit (young due to its recent formation, but also due to the average age of its researchers) is remarkable, guaranteeing an undeniably global standing within various academic networks. The proximity to high-level training centers and the attractiveness of the unit enables hiring of top-quality PhD students (currently 12 PhD students). All of these elements contribute to the excellent, high-standard scientific output of the unit.

Strengths and opportunities related to the context

The CVC unit works with a strong focus on its scientific goals, addressing the topics of machine learning, computer vision and medical imaging. The unit addresses machine learning techniques, while putting them into practice in the field of medical imaging and computer vision. During the unit's development (2011-2013), the arrival of researchers from different international universities has reinforced the theoretical aspect of the work involving machine learning.

The unit's scientific output is of a very high quality and its rich range of topics (the different aspects that are dealt with) is an important asset. The CVC unit is well established in a network of international collaborations. It is remarkably well prepared for approaching in an original and creative manner such complex problems as the analysis of medical images or the problems of machine learning when, for example, the data are incomplete. The laboratory attracts PhD candidates as well as young researchers and high quality university teachers and researchers.

The CVC is involved in a large number of various contracts which contribute to more than half of its consolidated budget. It's worth noting that the unit has managed to establish a software platform named DROP (Discrete Deformable Registration) which has become an industrial product marketed by Intrasense Industrial partner in connection with the Myriam platform.

Weaknesses and threats related to the context

The wealth and the amount of research can sometimes make it rather difficult to understand its thematic structure. It is undeniable that input concerning many aspects of computer vision is put forward, however, it can be difficult to link together different topics. During the visit of the unit the connections between different research directions have been better clarified and the comitee has observed strong interaction between machine learning axis and the advances in the different applications of medical imaging.

While the "compact" nature of the CVC is an advantage when it comes to the high level of reactivity, it also makes the unit potentially more vulnerable. As we mentioned in the introduction, the small size of the unit can be a weakness if one thinks in terms of unity. Indeed, if one of the collaborators left, for example, the entire structure could be weakened : one researcher to a topic.

The link between the unit and the local or national academic environment remains an important question. The involvement of the unit in the national research environment (for example in GDR CNRS) should be reinforced or better precised.

Recommendations

The quality, amount, and wealth of the CVC unit's research cannot be stressed enough. As previously stated, the international foundations of the unit are an important element, which obviously contributes to the quality of the work. The fact that the CVC members are present in a great variety of networks, committees and international projects is a proof of that. We are confident that the unit will strenthen its international recognition even further in the future. The precise thematic positioning of the CVC is also a main factor of the success and recognition.

The unit's small size can be seen as a strength as it allows for a large amount of reactivity and project-based work. However, the small size can also be a weakness since each research direction of the CVC critically depends on a particular researcher. We thus recommend to take special care of preserving the current unit and extending the unit with more permanent members in the near future. The number of Post-docs and visitors can also be increased in the future.

While the CVC is well-recognized internationally, there is a room for better integration of the unit with the national research environment. In the future, the unit should developp collaborations with the new Université Paris-Saclay, aiming to reinforce its role as an important player in the field of Machine Learning.

Moreover, the unit should identify appropriate medical partners and developp strong interaction with one or several hosipitals on specific medical topics. During the visit, a new link with the Pompidou hospital has been identified, this collaboration should be reinforced in the future.

3 • Detailed assessments

Assessment of scientific quality and outputs

The unit's main objectives is to advance scientific progress in computational vision by addressing the three main themes: machine learning and optimization; computer vision; and biomedical image analysis. Mastering different theoretical approaches has enabled the unit to propose new solution and to make contributions in several areas including (i) learning with partially annotated data (weakly-supervised learning), to optimisation of higher order graphical models, for example. In addition, various ideas have been put forward concerning feature detection methods, which are an entry point of the chain. The studied questions primarily involve invariance of image descriptors to changes in scale, shape as well as intra-class variations. The coherence of the scientific project is reinforced by the fact that feature extraction is mainly approached by machine learning methods rather than from a signal processing perspective. The intersection of the first two themes (machine learning and computer vision) is therefore very strong in regard to various aspects.

The third line, focusing on medical imaging, is based on a similar type of methods. Its aim is to offer tools that pinpoint precise needs (instead of adapting non-specialized tools for biomedical uses). Some of the methods developed by the unit address medical applications using prior model or knowledge, for example the CT reconstruction with compressed sensing approach (minimization) or the problem of small training sets for brain tumor segmentation (Machine Learning). The majority of the developed mehtods use Machine Learning and Optimization.

The unit is a very small unit, but on the national scale it is a reasonably-sized targeted research unit. Due to its structure and recruiting, the CVC covers various scientific competences (optimisation, graphical models, Markov random fields, low level features, etc.) but also supplementary ones, which make it all the richer.

Overall, the unit's scientific output is of a very high standard, given both the quality of the research and the impact of its results on the scientific community. The unit has published 31 articles in peer-reviewed journals, 120 international conferences, 5 book chapters or books. These articles have been published in high quality journals of the field (IEEE Trans. on PAMI, IEEE Trans. on Image Processing, Int Journal Computer Vision, etc.). It should be noted, that top conferences of machine learning (NIPS, ICML) and computer vision (CVPR, ICCV, ECCV) are highly selective with typical acceptance rate around 25%. Publications in such conferences are considered at least as important as journal publications. The average number of articles by permanent unit member over the considered period is 6.

The CVC unit is involved in an Inria Joint Team SPLENDID created in 2012 (Self-Paced Learning for Exploiting Noisy, Diverse and Incomplete Data), which brings together CVC members and researchers from Stanford University, working together on machine learning problems. Finances issued from SPLENDID project are mainly devoted for exchanges and travels.

Assessment of the unit's academic reputation and appeal

The unit benefits from a high level of recognition, as shown by its high quality output but also by its involvement in organising top quality conferences (CVPR, ECCV, ICCV …), steering committees, and evaluation committees. Some members of the CVC participate in editorial boards of leading journals (IEEE PAMI, IJCV, IVC, Editor in Chief for CVIU). Furthermore, the unit has received several distinctions (Best paper awards at CVPR and ECCV, BMVA Sullivan Thesis Prize, IEEE fellow). Unit’s national and international recognition is also visible from a large number of invited talks given by unit members at both national and international events. Academic reputation of the unit is also highlighted by the prestigeous ERC grant awarded to the CVC leader in 2011.

Since its creation, the unit has recruited several researchers following international careers. Each researcher came from a prestigious university which reinforces the unit's international standing.

The unit was able to obtain financial supports from many different sources including national calls for projects (3 ANR projects, 1 DGA project, 5 regional projects), international initiatives (FP, ERC) and from grants with industry.

Assessment of the unit's interaction with the social, economic and cultural environment

CVC takes part in contractual activities with several industrial partners. Given the size of the unit, this collaboration is substantial and includes several CIFRE contracts, many patent applications and software transfers. The presentation of the unit at the meeting has given further details on the industrial collaboration and the field covered by industrial projects (in particular within medical imaging).

The unit has several patents (6), some validated, some pending. It would be interesting to obtain more details about both the thematic outline of these industrial collaborations and the results obtained or aimed for.

Within the close academic environment, CVC actively collaborates with the Supélec's Electronic Signals and Systems department and the Parietal Inria / CEA-Neurospin Center. This collaboration is reflected by thesis co-supervision, and by having obtained a Digiteo excellence chair. All these collaborations founded on thematic complementarity are reinforced by many high quality publications.

Assessment of the unit's organisation and life

Given the small size of the unit, it did not yet build a substantial structural organization. The unit works by projects in connection to particular research topics and allocated funding. There is a large degree of collaboration between researchers of the unit enabling sharing of knowledge and expertise across different research topics. The director of the unit takes a role of the unit's scientific leader, assisted by an administrative manager. As the medium-term objective of the unit is to grow stronger and larger in numbers, particularly in the number of researchers, it will probably be necessary to organize the work of the unit by teams having specific goals and identities.

Assessment of the unit's involvement in training through research

The unit's teaching staff are involved in and are in charge of the machine learning / computer vision / biological signal processing major of the Applied Mathematics department of the École Centrale de Paris, a degree linked to the MVA (ENS-Cachan-Centrale-X-ENS-Ponts-Mines) MSc program in Applied Mathematics, Machine Learning and Computer Vision. Thanks to this involvement there is a large amount of interaction between the research unit and the top engineering students in the Parisean area, which makes it possible to recruit top-level students.

The CVC is taking part in the Massive Open Online Course Initiatives (MOOC), on the topic of Machine Learning. This is yet another source of recognition for the unit, but it is alse a means to become known to an audience of international students. The CVC is also taking part in the organisation of a Summer School: Modalities, Methodologies & Clinical Research (BIOMED).

Despite its recent creation, the unit has a very rich record of thesis defenses, with 3 HDRs and 18 PhDs over the period of study (some of the PhDs are co-supervised). Every thesis conducted during the relevant period resulted in at least one publication in an international journal. PhD graduates from CVC all find jobs either in academia or industry (11 are working in the industry, 5 in higher education and research, and 2 are studying at a post-doctoral level). The average length of the phD is 3.7 years.

The CVC unit conducts a training policy for its PhD scholars in various ways. It organizes bi-monthly seminars that include talks by external speakers and work presentation by the members of the unit. Student of the unit participate in thematic schools and various conferences. In addition, students are encouraged to spend a trimester at international research laboratories. PhD students also undertake training programs offered by the doctoral school of the Ecole Centrale de Paris and INRIA.

Assessment of the strategy and the five-year plan

For the next five years, the unit has planned to continue research along its three current research directions (Machine Learning and optimisation, Computer vision and Biomedical Image Analysis). For each of these directions scientific challenges have been identified. It's clear that the development of new Machine Learning tools will play a major role for computer vision and medical image analysis. The proposed research on learning from large-scale and partially annotated data as well as efficient inference techniques for higher-order graphical models is timely in the general scientific context, but is also particularly well-suited to the research direction of the unit.

Another ground-breaking scientific direction, which has already been brought forward on several occasions, is that of addressing big data including large-scale repositories with 3D and multi-modal data. Analysis of large-scale data will require revision of certain approaches but also addressing the problem of computational complexity.

Concerning medical imaging, the focus is mainly on in-vivo imaging, which presents new challenges such as accurate real time image analysis. In the medical field, as well as when integrating 3D information, adapting models for a longitudinal study (longitudinal organ modelling) has been put forward, in order to analyse a pathology's evolution.

The future plan of the CVC is scientifically coherent and relies on the unit's well-proven skills, which make its realization possible. The topics approached are original, however, direct practical applications of the first two directions (Machine Learning and Computer Vision) have not been detailed.

In regard to the unit itself, the unit has clearly shown its wish to grow by increasing the number of permanent researchers, which is of course a prerequisite for the structure's continuity. A unit-building objective has been mentioned following the model of Inria, that is to say project units of 3-4 people working on the three mentioned topics. This ensures a high scale of reactivity but one must make sure that the new units continue working together in a coherent fashion.

During the reorganisation of Parisian laboratories and universities, the CVC plans to consider long-term collaborations with other research groups. A search for new partners will continue previously initiated discussion and will aim to further improve scientific output of the unit as well as to preserve the units' identity and visibility. In particular the unit plans interactions with the new Université Paris-Saclay, aiming to reinforce their role as an important player in the field of Machine Learning. It also appears important to developp a very strong interaction with hospital partners. The CVC receives strong support from École Centrale Paris in regard to its future growth and scientific development.

4 • Conduct of the visit

Visit date:

Start:	February 5 th, 2014 at 9.00 a.m
End:	February 5th, 2014 at 4.00 p.m

Visit site:	Center for Visual Computing
Institution:	École Centrale de Paris
Address :	Grande Voie des Vignes, Chatenay Malabry

Conduct or programme of visit:

9.00 am	Welcome
9.15 am	Committee Meeting (in camera meeting)
9.30 am	Welcome talk by the AERES scientific delegate
9.40 – 10.30 am	Presentation of achievements and perspectives of the CVC unit by the Director
10.30 – 11.00 am	Coffee Break
11.00 – 12.00 pm	Meetings with the staff (ingeniors-administrative staff, PhD students, searchers) (in camera meetings)
12.00 – 12.30 pm	Meeting with representative(s) of the unit's supervising institutions (in camera meeting)
	Lunch
1.30 – 2.00 pm	Meeting with the director of CVC (in camera meeting)
2.00 – 4.00 pm	Committee meeting (in camera meeting)
4.00 pm	End

5 • Supervising bodies' general comments

Despite the AERES' requests, it had not received any comments by the time this evaluation was published.