Activity Report 2017

Section Contracts and Grants with Industry

CAIRN Project-Team (section vide)

CELTIQUE Project-Team (section vide)

<p style="text-align:center">**CIDRE Project-Team**</p>

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

- **HP (2013-2019): Embedded Systems Security** We aim at researching and prototyping low-level intrusion detection mechanisms in embedded system software. This involves mechanisms in continuation of previous work realized by our team as well as investigating new techniques more directly tied to specific HP device architectures. Our main objective is to monitor low-level software (firmware, OS kernels, hypervisors) thanks to a dedicated external co-processor. Ronny Chevalier is doing is PhD in the context of this project. Being under NDA, details about this research program cannot be provided.

8.2. Bilateral Grants with Industry

- **Orange Labs: Privacy-preserving location-based services** Solenn Brunet has completed her PhD thesis in November 2017 within the context of a CIFRE contract with Orange Labs Caen. Her PhD subject was about privacy-preserving services that are able to provide the service to the user while preserving his privacy. In particular, Solenn Brunet has designed new cryptographic primitives to build anonymous accreditation and she has used these primitives to provide data anonymization mechanisms in the context of e-voting and e-cash.

- **DGA: BGP-like Inter Domain routing protocol for tactical mobile ad hoc networks: feasibility, performances and quality of service** Florian Grandhomme has completed his PhD thesis in September 2017 in cooperation with DGA-MI. The subject of the PhD was to propose new secure and efficient algorithms and protocols to provide inter-domain routing in the context of tactical mobile ad hoc network. The proposed protocol handles context modification due to the mobility of MANET, that is to say split of a MANET, merge of two or more MANET, and also handles heterogeneity of technology and infrastructure. The solution is independent from the underlying intra-domain routing protocol and from the infrastructure: wired or wireles, fixed or mobile.

- **DGA: Visualization for security events monitoring** Damien Crémilleux has started his PhD thesis in October 2015 in the context of a cooperation with DGA-MI. The subject of the PhD is to define relevant representations to allow front-line security operators to monitors systems from a security perspective. A first proposal was made that led to a tool, VEGAS, that allows to monitor large quantities of alerts in real time and to dispatch these alerts in a relevant way to security analysts.

- **DGA: Intrusion Detection in Distributed Applications** David Lanoé has started his PhD thesis in October 2016 in the context of a cooperation with DGA-MI. His work is focussing on the construction of behavioral models (during a learning phase) and their use to detect intrusions during an execution of the modelled distributed application.

- **Nokia: Risk-aware security policies adaptation in modern communication infrastructures** Pernelle Mensah was hired in January 2016 on this CIFRE funding in order to work on unexplored aspects of information security, and in particular response strategies to complex attacks, in the context of cloud computing architectures. The use case proposed by our industrial partner is a multi-tenant cloud computing platform involving software-defined networking in order to provide further flexibility and responsiveness in architecture management. The topic of the thesis is to adapt and improve the current risk-aware reactive response tools, based on attack graphs and adaptive security policies, to this specific environment, taking into account the heterogeneity of actors, platforms, policies and remediation options.

- **Thales: Privacy and Secure Multi-party Computation** Aurélien Dupin has started his PhD thesis in January 2016 within the context of a CIFRE contract with Thales. His PhD subject concerns secure multi-party computation. Secure two-party computation provides a way for two parties to compute a function, that depends on the two parties' inputs, while keeping them private. Known since the 1980s, Yao's garbled circuits appear to be a general solution to this problem, in the semi-honest model. Decades of optimizations have made this tool a very practical solution. However, it is well known that a malicious adversary could modify a garbled circuit before submitting it. Many protocols, mostly based on cut-&-choose, have been proposed to secure Yao's garbled circuits in the presence of malicious adversaries. Nevertheless, how much an adversary can modify a circuit and make it still executable have not been studied. In the context of his PhD, Aurélien Dupin is interested by such a question.

- **Thales: Combining Attack Specification and Dynamic Learning from traces for correlation rule generation** Charles Xosanavongsa has started his PhD thesis in December 2016 in the context of a CIFRE with Thales. His work will focus on the construction of correlation rules. In previous work on correlation rule generation, the usual approach is static. It always relies on the description of the supervised system using a knowledge base of the system. The use of correlation trees is an appealing solution because it allows to have a precise description of the attacks and can handle any kind of IDS. But in practice, the behavior of each IDS is quite difficult to predict, in particular for anomaly based IDS. To manage automatically the correlation rules (and adapt them if necessary), we plan to analyze synthetic traces containing both anomaly based and misused based IDS alerts resulting from an attack.

- **Ministry of Defence: Visualisation for the characterization of security events** Laetitia Leichtnam has started his PhD thesis in November 2016 in the context of a contract between CentraleSupelec and the French Ministry of Defence. His work consists in presenting events appearing in heterogeneous logs as a dependency graph between the lines of logs. This permits to the administrator to investigate easily the logs to discover the different steps that has performed an attack in the supervised system.

- **ANSSI: Security of Low-level Components** Thomas Letan has started his PhD thesis in the context of a contract between CentraleSupelec and the French National Computer Security Agency (ANSSI). His work consists in using formal methods to specify hardware/software security mechanisms and to verify that they correctly enforce some security policies.

HYCOMES Project-Team

6. Bilateral Contracts and Grants with Industry

6.1. GLOSE

The simulation of system-level models requires synchronizing, at simulation-time, physical models with software models. These models are developed and maintained by different stakeholders: physics engineers, control engineers and software engineers. Models designed by physics engineers are either detailed 3D finite-elements models, with partial differential equations (PDEs), or finite-dimension 0D models (obtained by model reduction techniques, or by empirical knowledge) expressed in modeling languages such as Simulink (with ordinary differential equations, or ODEs), Modelica (with differential algebraic equations, or DAEs), or directly as a C code embedding both the differential equations and its discretization scheme. Control engineers favor Matlab/Simulink, mainly because of its toolboxes and ease of use. Computer scientists program or model real-time reactive software, either with a dedicated language, for instance SCADE, hierarchical state machines or sequence/activity diagrams (as in UML/SysML) or directly in C. Coupling together heterogeneous models and programs, so that they can be co-simulated, is not only a technological challenge, but more importantly raises several deep and difficult questions: Can we trust simulations? What about their reproducibility? Will it be possible to simulate large systems with hundreds to thousands of component models?

The objective of the GLOSE project is to address these objectives, and propose both sound foundations and practical technological solutions to system level modeling and simulation. The GLOSE project has started in December 2017 and is funded by Safran, in the realm of the DESIR joint Safran-Academia research network. The academic teams contributing to GLOSE are the Hycomes, Diverse and Kairos Inria teams, and IRIT/CNRS in Toulouse.

<p style="color:red;text-align:center;">**PACAP Project-Team**</p>

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. Nano 2017 PSAIC

Participants: Arif Ali Ana-Pparakkal, Erven Rohou.

Nano 2017 PSAIC is a collaborative R&D program involving Inria and STMicroelectronics. The PSAIC (Performance and Size Auto-tuning through Iterative Compilation) project concerns the automation of program optimization through the combination of several tools and techniques such as: compiler optimization, profiling, trace analysis, iterative optimization and binary analysis/rewriting. For any given application, the objective is to devise through a fully automated process a compiler profile optimized for performance and code size. For this purpose, we are developing instrumentation techniques that can be focused and specialized to a specific part of the application aimed to be monitored.

The project involves the Inria teams PACAP, AriC, CAMUS and CORSE. PACAP contributes program analyses at the binary level, as well as binary transformations. We will also study the synergy between static (compiler-level) and dynamic (run-time) analyses.

7.2. Bilateral Grants with Industry

7.2.1. Intel research grant INTEL2014-8957

Participants: André Seznec, Biswabandan Panda, Fernando Endo.

Intel is supporting the research of the PACAP project-team on "Mixing branch and value prediction to enable high sequential performance".

7.2.2. Intel research grant INTEL2016-11174

Participants: André Seznec, Pierre Michaud, Kleovoulos Kalaitzidis, Niloofar Charmchi.

Intel is supporting the research of the PACAP project-team on "Design tradeoffs for extreme cores".

<p style="text-align:center">**SUMO Project-Team**</p>

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. ADR Softwarization of Everything

Joint Nokia-Inria research lab: Several researchers of SUMO are involved in the joint research lab of Nokia Bell Labs France and Inria, in a common research team called "Softwarization of Everything". The objective of this joint team is to design programming and management methods for software defined networks. Several other Inria teams take part to this group: Convecs, Diverse, Spades. Within this team, SUMO focuses on the management of reconfigurable systems, both at the edge (IoT based applications) and in the core (e.g. virtualized IMS systems). In particular, we focus on control and diagnosis issues for such systems.

8.1.2. Alstom P22

Joint Alstom-Inria research lab: Several researchers of SUMO are involved in the joint research lab of Alstom and Inria, in a common research team called P22. On Alstom side, this joint research team involves researchers of the ATS division (Automatic Train Supervision). The objective of this joint team is to evaluate regulation policies of urban train systems, to assess their robustness to perturbations and failures, to design more efficient regulation policies and finally to provide decision support for human regulators. The project started in march 2014. A second phase of the project started in 2016, for a duration of three years. This covers in particular the CIFRE PhD of Karim Kecir.

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

- CISCO (http://www.cisco.com) contract (2017–2022) to work on graph analysis of malware

8.2. Bilateral Grants with Industry

- CISCO (http://www.cisco.com) one grant (2016–2019) to work on semantical analysis of malware
- Thales (https://www.thalesgroup.com) one CIFRE (2016–2019) to work on verification of communication protocols, one grant (2018–2019) to work on learning algorithms
- Oberthur Technologies (http://www.oberthur.com/) one grant (2016–2020) to work on fuzzing and fault injection
- Secure IC (http://www.secure-ic.com/), one CIFRE (2017–2020) to work on post-quantum cryptography

TEA Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Grants with Industry

8.1.1. *Mitsubishi Electric R&D Europe (2015-2018)*

Title: Analysis and verification for correct by construction orchestration in automated factories

Inria principal investigator: Jean-Pierre Talpin, Simon Lunel

International Partner: Mitsubishi Electric R&D Europe

Duration: 2015 - 2018

Abstract: The primary goal of our project is to ensure correctness-by-design in cyber-physical systems, i.e., systems that mix software and hardware in a physical environment, e.g., Mitsubishi factory automation lines. We develop a component-based approach in Differential Dynamic Logic allowing to reason about a wide variety of heterogeneous cyber-physical systems. Our work provides tools and methodology to design and prove a system modularly.

<p style="text-align:center">**ASPI Team**</p>

6. Bilateral Contracts and Grants with Industry

6.1. Bilateral grants with industry

See 4.1 .

6.1.1. Hybrid indoor navigation — PhD project at CEA LETI

Participants: François Le Gland, Kersane Zoubert–Ousseni.

This is a collaboration with Christophe Villien (CEA LETI, Grenoble).

The issue here is user localization, and more generally localization–based services (LBS). This problem is addressed by GPS for outdoor applications, but no such general solution has been provided so far for indoor applications. The desired solution should rely on sensors that are already available on smartphones and other tablet computers. Inertial solutions that use MEMS (microelectromechanical system, such as accelerometer, magnetometer, gyroscope and barometer) are already studied at CEA. An increase in performance should be possible, provided these data are combined with other available data: map of the building, WiFi signal, modeling of perturbations of the magnetic field, etc. To be successful, advanced data fusion techniques should be used, such as particle filtering and the like, to take into account displacement constraints due to walls in the building, to manage several possible trajectories, and to deal with rather heterogeneous information (map, radio signals, sensor signals).

The main objective of this thesis is to design and tune localization algorithms that will be tested on platforms already available at CEA. Special attention is paid to particle smoothing and particle MCMC algorithms, to exploit some very precise information available at special time instants, e.g. when the user is clearly localized near a landmark point.

In some applications, real time estimation of the trajectory is not needed, and a post processing framework may provide a better estimation of this trajectory. In [57], we present and compare three different algorithms to improve a real time trajectory estimation. Actually, two different smoothing algorithms and the Viterbi algorithm are implemented and evaluated. These methods improve the regularity of the estimated trajectory by reducing switches between hypotheses.

Post processing indoor navigation is interesting, for example to develop crowdsourcing analysis. The post processing framework allows to provide a better estimation than in a real time framework. The main contribution of [17] is to present a piecewise parametrization using IMU (inertial measurement unit) and RSS (received signal strength) measurements only, which lead to an optimization problem. A Levenberg–Marquardt algorithm improved with simulated annealing and an adjustment of RSS measurements data leads to a good estimation (55% of the error less than 5 meters) of the trajectory.

6.1.2. Bayesian tracking from raw data — CIFRE grant with DCNS Nantes

Participants: François Le Gland, Audrey Cuillery.

This is a collaboration with Dann Laneuville (DCNS Nantes).

After the introduction of MHT (multi–hypothesis tracking) techniques in the nineties, multitarget tracking has recently seen promising developpments with the introduction of new algorithms such as the PHD (probability hypothesis density) filter [50], [56] or the HISP (hypothesised filter for independent stochastic populations) filter [40]. These techniques provide a unified multitarget model in a Bayesian framework [54], which makes it possible to design recursive estimators of a *multitarget probability density*. Two main approaches can be used here: sequential Monte Carlo (SMC, also kown as particle filtering), and Gaussian mixture (GM). A third approach, based on discretizing the state–space in a possibly adaptive way, could also be considered despite its larger computational load. These methods are well studied and provide quite good results for *contact output*

data, which correspond to regularly spaced measurements of targets with a large SNR (signal–to–noise ratio). Here, the data is processed (compared with a detection threshold) in each resolution cell of the sensor, so as to provide a list of detections at a given time instant. Among these methods, the HISP filter has the best performance/computational cost ratio.

However, these classical methods are unefficient for targets with a low SNR, e.g. targets in far range or small targets with a small detection probability. For such targets, preprocessing (thresholding) the data is not a good idea, and a much better idea is to feed a tracking algorithm with the raw *sensor output* data directly. These new methods [24] require a precise modeling of the sensor physics and a direct access to the radar (or the sonar) raw data, i.e. to the signal intensity level in each azimuth/range cell. Note that these new methods seem well suited to new types of sensors such as lidar, since manufacturers do not integrate a detection module and do provide raw images of the signal intensity level in each azimuth/range cell.

The objective of the thesis is to study and design a tracking algorithm using raw data, and to implement it on radar (or sonar, or lidar) real data.

<h1 style="color:red; text-align:center">I4S Project-Team</h1>

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Contracts with SVS

Participants: Laurent Mevel, Michael Doehler.

I4S is doing technology transfer towards SVS to implement I4S technologies into ARTEMIS Extractor Pro. This is done under a royalty agreement between Inria and SVS .

In 2014, the damage detection toolbox has been launched http://www.svibs.com/products/ARTeMIS_Modal_Features/Damage_Detection.aspx.

In 2015, SVS and Inria have earned an Innobooster grant to help transfer algorithms in 2016 Artemis Extractor Pro.

In 2016, uncertainty quantification for modal analysis has been launched.

In 2017, a new Innobooster grant has been obtained for the uncertainty analysis of mode shapes in Artemis.

8.1.2. Contract with SNCF: DEMETER

Participants: Vincent Le Cam, Quentin Bossard, Mathieu Le Pen.

IFSTTAR's engineers Arthur Bouche and Laurent Lemarchand are contributing to this project.

DEMETER is one of the major projects for I4S in terms of strategy, scientific and technological impact.

DEMETER is a meta project whose global objective is the validation of the contribution of the Internet of Things (IOT) applied to the health monitoring of railway items. SNCF and IFSTTAR have signed a roadmap for safety relevant items, where wireless monitoring and smart algorithms could bring strong improvements to SNCF in terms of real-time maintenance or predictive maintenance. Those items are, amongst others:

- Crossing engine motor monitoring
- Needle motor monitoring
- Axel counter monitoring
- Train detection pedal monitoring

In each case, a prototype of a specific wireless and smart sensor is designed (that may or may not use PEGASE 2 platform), installed along railway lines in service and data are transmitted wirelessly to the cloud supervisor at IFSTTAR for evaluation in SHM algorithms.

In particular, during 2017 SNCF and IFSTTAR have performed following common works:

- finalization of the TRAIN PEDAL DETECTION instrumentation with smart sensors using new wireless and industrial IOT protocoles: LoRa and Sigfox. A specific pedal is now subject of in situ test led by SNCF
- axel counter monitoring has been the major R&D subject of 2017: 2 entire and specific smart sensors have been designed, programmed and installed at Chevilly specific SNCF testbench (e.g. with real train passages). Specific algorithms (such as PID and Pattern Recognition) have been modeled and programmed into PEGASE2 platform for these new sensors.

For the future, new projects related to

- water-level monitoring around railways has been setup
- ballast vibration monitoring of railways has been setup
- "unshunting of electrical lines at train passage" detection around railways

have been initiated with SNCF R&D department.

8.1.3. *Contracts with SDEL-CC (VINCI Group)*
Participants: Vincent Le Cam, Mathieu Le Pen.

This work was done in collaboration with Laurent Lemarchand, and Arthur Bouche at IFSTTAR, SII, Nantes.

Following a 2016 contract, a new contract was signed in 2017 until end 2018, with the company SDEL-CC, a 100% daughter of the VINCI Group, Energy department. The project exploits the unique time stamp capacity of the PEGASE 2 platform up to 50 nanoseconds, independently of distances in the network of PEGASE2 nodes. The synchronization capacity is employed to design a sensor prototype based on PEGASE 2 to time-stamp the current wave after a lightning impact on a high-voltage line. By knowing the exact time, the wave can be seen at each extremity of the electrical line to localize accurately the lightning impact point.

During 2017, a real high-voltage electrical line has been instrumented: at each end of the line, 2 sensors have been set up and data are sent in real time to a cloud platform. Furthermore, the software of the platform was optimized: at the embedded level (i.e. on PEGASE 2 wireless system) with new algorithms to correct time synchronization up to some 10 nanoseconds, at the cloud level with a specific QT C++ Interface to display results (i.e. lightning localization on electrical line) and to transform raw data into ComTrade standard representation

Discussions are ongoing with SDEL-CC to transform the prototype into a future product. In 2017 it has to be mentioned that the project has been submitted to VINCI International challenges (over 150 000 collaborators) and has been awarded with The Best Vinci Innovation Award.

8.2. Bilateral Grants with Industry

8.2.1. *PhD project with EDF – Electrical device ageing monitoring*
Participants: Nassif Berrabah, Qinghua Zhang.

A joint PhD project between Inria and EDF (Electricité de France) was started in December 2014 and finished in November 2017 with Nassif Berrabah's PhD thesis defense. The purpose of this study is to develop methods for the monitoring of electrical instruments in power stations, in order to prevent failures caused by ageing or accidental events. This project has been funded by EDF and by the ANRT agency. The main outcome of this project is an efficient reflectometry-based method for resistive fault detection, localization and quantification, capable of dealing with both distributed and localized faults, with associated data processing tools taking into account practical constraints in industrial applications. These results have led to a patent jointly filed by EDF and Inria.

IPSO Project-Team (section vide)

<p style="text-align:center;color:red;font-weight:bold;">DYLISS Project-Team</p>

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

Participants: Olivier Dameron, Anne Siegel, Méline Wery.

Our software *AskOmics* was considered as relevant by the SANOFI bio-medical company in order to facilitate the integration and the query of the data produced by their scientists. A former Ph.D. of Dyliss who designed the first prototypes of *AskOmics* was recruited by SANOFI. Since then, SANOFI is included in the developer's team of *AskOmics* and a joint Dyliss–SANOFI CIFRE Ph.D. thesis started about the integration of complementary reasoning features to SPARQL queries in Oct. 2017.

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FLUMINANCE Project-Team

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8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Contract CERSAT/IFREMER

Participants: Etienne Mémin, Valentin Resseguier.

duration 39 months. This partnership between Inria and Ifremer funded the PhD of Valentin Resseguier, which aimed to study image based data assimilation strategies for oceanic models incorporating random uncertainty terms. The goal targeted will consist in deriving appropriate stochastic version of oceanic model and on top of them to devise estimation procedures from noisy data to calibrate the associated subgrid models.

8.1.2. Contract inter Carno IFREMER Inria

Participants: Etienne Mémin, Thibaut Tronchin.

duration 36 months. This contract was centred on the elaboration of an image-based tools for the analysis of the hydraulic load of an immersed body. This project tooke place within an inter Carnot cooperation between Ifremer and Inria.

8.1.3. Contract ITGA

Participants: Dominique Heitz, Etienne Mémin.

duration 36 months. This partnership between Inria, Irstea and ITGA funds the PhD of Romain Schuster. The goal of this PhD is to design new image-based flow measurement methods for the study of industrial fluid flows. Those techniques will be used in particular to calibrate industrial fume hood.

8.1.4. Contract CSTB

Participants: Mohamed Yacine Ben Ali, Dominique Heitz, Etienne Mémin.

duration 36 months. This partnership between Inria, Irstea and CSTB funds the PhD of Yacine Ben Ali. This PhD aims to design new data assimilation scheme for Reynolds Average Simulation (RANS) of flows involved in wind engineering and buildings construction. The goal pursued here consists to couple RANS models and surface pressure data in order to define data driven models with accurate turbulent parameterization.

8.1.5. ANDRA project

Participants: Yvan Crenner, Benjamin Delfino, Jean-Raynald de Dreuzy, Jocelyne Erhel.

Contract with ANDRA (National Agency for Nuclear Waste)
Duration: three years from November 2015.
Title: reactive transport in fractured porous media
Coordination: Jocelyne Erhel.
Partners: Geosciences Rennes.
Abstract: Even in small numbers, fractures must be carefully considered for the geological disposal of radioactive waste. They critically enhance diffusivity, speed up solute transport, extend mixing fronts and, in turn, modify the physicochemical conditions of reactivity around possible storage sites. Numerous studies in various fields have shown that fractures cannot be simply integrated within an equivalent porous medium with a simple enhancement of its petro-physical properties (porosity and permeability). We propose a combined numerical and experimental approach to determine the influence on reactivity of typical fracture patterns found in some radioactive waste applications.

8.1.6. IFPEN project

Participants: Bastien Hamlat, Jocelyne Erhel.

Contract with IFPEN (Institut Français du Pétrole et Energies Nouvelles)
Duration: three years from October 2016.
Title: Fully implicit Formulations for the Simulation of Multiphase Flow and Reactive Transport
Coordination: Jocelyne Erhel.
Abstract: Modeling multiphase flow in porous media coupled with fluid-rock chemical reactions is essential in order to understand the origin of sub-surface natural resources and optimize their extraction. This project aims to determine optimal strategies to solve the coupled transport and chemical reaction equations describing the physical processes at work in reactive multiphase flow in porous media. Three different formulations show great potential to accurately solve these equations. Two are fully implicit ("Reactive Coats" and "Semi-smooth Newton)" and one is an operator splitting approach. These formulations are still incomplete at the moment. The work will focus on extending the existing formulations to more complex physical phenomena, study their stability, convergence and theoretical equivalence. Another objective is to provide practical solutions to efficiently solve the resulting non-linear systems.

<p align="center" style="color:red">GENSCALE Project-Team</p>

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Processing in memory

Participants: Charles Deltel, Dominique Lavenier.

The UPMEM company is currently developing new memory devices with embedded computing power (http://www.upmem.com/). GenScale investigates how bioinformatics algorithms can benefit from these new types of memory (see section New Results).

8.2. Bilateral Grants with Industry

8.2.1. Enancio Start-Up

Participants: Jennifer Del Giudice, Stephane Picq, Guillaume Rizk.

After 2 years of development the EnginesOn project has led to the creation of Enancio in August 2017 (http://www.enancio.fr). Enancio main focus is to give the biologist all the resources needed to decipher the information held on a biological molecule such as DNA, without worrying about the informatics behind it. The start-up provides a software platform available through the net with analysis workflows that have been conceived and validated by the field experts, solutions to handle massive data, and health data certified computational infrastructure. Simplification, optimization and faster execution of analyses workflows are the main focuses of the company. Enancio workflows uses the GATB-core library developed by GenScale.

8.2.2. Rapsodyn project

Participants: Dominique Lavenier, Claire Lemaitre, Sebastien Letort, Pierre Peterlongo.

RAPSODYN is a long term project funded by the IA ANR French program (Investissement d'Avenir) and several field seed companies, such as Biogemma, Limagrain and Euralis (http://www.rapsodyn.fr/). The objective is the optimization of the rapeseed oil content and yield under low nitrogen input. GenScale is involved in the bioinformatics work package, in collaboration with Biogemma's bioinformatics team, to elaborate advanced tools dedicated to polymorphism detection and analysis.

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SERPICO Project-Team

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8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Contract with Innopsys: Tissue microarrays (TMA) image analysis

Participants: Charles Kervrann.

Collaborators: Vincent Paveau and Cyril Cauchois (Innopys company).
A three-year contract has been established with Innopsys in 2013 to support the PhD thesis of Hoai-Nam Nguyen. The objective was to investigate and develop methods and algorithms dedicated to fluorescence images acquired by scanners and devices designed by the company. In this project, we focused on localization and segmentation of fluorescence tissue microarrays (TMA) cores in very large 2D images, de-arraying of digital images and correction of grid deformation adapted to devices, correction of scanning artifacts to improve image reconstruction and deconvolution of fluorescence TMA images. The algorithms are currently embedded into software and hardware products designed by Innopsys.

8.1.2. Contract (CIFRE) with Technicolor: Semantically meaningful motion descriptors for video understanding

Participants: Juan Manuel Perez Rua, Patrick Bouthemy.

Collaborators: Tomas Crivelli and Patrick Pérez (Technicolor).

A three-year contract has been established with Technicolor in January 2015 for a CIFRE grant supporting the PhD thesis of Juan Manuel Pérez Rúa. The purpose was to investigate new methods for extracting meaningful mid-level motion-related descriptors that may help for the semantic discovery of the content. First, we addressed the occlusion detection problem and proposed a novel approach where occlusion is formulated in terms of visual reconstruction. Contrary to the usual approaches, the proposed alternative does not critically depend on a pre-computed, dense displacement field, while being shown to be more effective. Second, we developed two hierarchical motion segmentation methods involving a compositional motion representation. The first one follows a frame-based labeling approach which amounts to minimizing a global energy function. The second one is trajectory-based and relies on tree-structured learning and sparse coding.

8.1.3. Contract with OBSYS: microscope set-up control and inverse problems in microscopy

Participants: Giovanni Petrazzuoli, Charles Kervrann.

Collaborators: Charles Gudeudry (OBSYS).

A two-year contract was established with OBSYS in 2016 for hiring an expert-engineer (12 months). The objective is to investigate and develop software for the control of a microscope set-up and the analysis of fluorescence images. Fast and robust algorithms have been especially developed to improve image reconstruction of 3D-TIRF microscope images. The algorithms will be embedded into platforms and devices designed by OBSYS. Giovanni Petrazzuoli has been hired in August 2017 on a full-time R&D engineer position in OBSYS (CDI). The collaboration with Inria will be pursued in 2018.

8.2. Bilateral grants with industry

8.2.1. Fourmentin-Guilbert Foundation: Macromolecule detection in cryo-electron tomograms

Participants: Emmanuel Moebel, Charles Kervrann.

Collaborator: Damien Larivière (Fourmentin-Guilbert Foundation).

A three-year contract was established with Fondation Fourmentin-Guilbert to partly support the PhD thesis of Emmanuel Moebel. The Fondation Fourmentin-Guilbert strives for building a virtual E. coli bacteria. Information about the position of macromolecules within the cell is necessary to achieve such a 3D molecularly-detailed model. The Fondation Fourmentin-Guilbert supports cutting-edge *in-situ* cryo-electron tomography combined with image processing at the Max-Planck Institute of Biochemistry to map the spatial distribution of the ribosomes, and obtain structural information on the complexes they form *in-situ* with cofactors and other ribosomes. The objective of the project is to explore novel methods from the field of 3D shape retrieval for identifying and counting macromolecules within a tomogram. This project is also supported by Région Bretagne.

VISAGES Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Siemens

In the context of the Neurinfo imaging platform, a master research agreement between Siemens SAS - Healthcare and University of Rennes 1 was signed in October 2011 for 5 years and renewed in 2016. This contract defines the terms of the collaboration between Siemens, Visages and the Neurinfo platform. From this research agreement contract, Neurinfo has received work in progress (WIP) sequences from Siemens in the form of object code for evaluation in the context of clinical research. The Neurinfo platform has also received source code of selected MRI sequences. As an example, the diffusion sequence code was modified to load arbitrary diffusion gradient waveforms for the FastMicroDiff project led by E. Caruyer. This is crucial in the collaboration since it enables the development of MRI sequences on site. Siemens currently provides research resources through the funding of a PhD student (Cédric Meurée: CIFRE Inria / Siemens grant).

8.2. Bilateral Grants with Industry

The PhD of Cédric Meurée is funded by Siemens Healthineers under a CIFRE grant.

ASAP Project-Team (section vide)

<p align="center" style="color:red">ASCOLA Project-Team</p>

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

Participants: Adrien Lebre [Contact point], Ronan-Alexandre Cherrueau, Alexandre Van Kempen.

During 2017, we agreed with Orange Labs (Lannion) to conduct a dedicated study on the evaluation of AMQP message bus alternatives within the OpenStack ecosystem. This bilateral contract ("Contrat de Recherche Externalisé") officially started in Sept 2017 for one year. With the allocated budget (100K), we hired a new research engineer, Alexandre Van Kempen. Alexandre Van Kempen works with Ronan-Alexandre Cherrueau (Temporary Resarch Engineer, hired in the context of the MERCURY InriHub) and Matthieu Simonin (Permanent Research Engineer from the Rennes Bretagne Atlantique Center) on conducting this analysis. In addition to extending the EnOS framework previously presented, they are performing several experiments with the support of the OpenStack open-source community (in particulat RedHat). The goal of the study is to identify major drawbacks of the default RabbitMQ solution with respect to the Fog/Edge requirements and evaluate whether some alternatives are available in the open-source ecosytem.

<center>DIONYSOS Project-Team</center>

8. Bilateral Contracts and Grants with Industry

8.1. Cifre contract on Device-Assisted Distributed Machine-Learning on Many Cores

Participants: Corentin Hardy, Bruno Sericola

This is a Cifre contract including a PhD thesis supervision (PhD of Corentin Hardy), done with Technicolor. The starting point of this thesis is to consider the possibility to deploy machine-learning algorithms over many cores, but out of the datacenter, on the devices (home-gateways) deployed by Technicolor in users' homes. In this device-assisted view, an initial processing step in the device may significantly reduce the burden on the datacenter back-end. Problems are numerous (power consumption, CPU power, network bandwidth and latency), but costs for the operator can be lowered and scale may bring some new level in data processing.

8.2. Cifre contract on Throughput Prediction in Mobile Networks

Participants: Yann Busnel

This is a Cifre contract (2015-2018) including a PhD thesis supervision (PhD of Alassane Samba), done with Orange, on cooperation in statistical approaches for the prediction of throughput without history. Throughput has a strong impact on user experience in cellular networks. The ability to predict the throughput of a connection, before it starts, brings new possibilities, particularly to Internet service providers. They could adapt contents to the quality of service really reachable by users, in order to enhance their experience.

8.3. Cifre contract on Mobile SDN architecture

Participants: Yassine Hadjadj-Aoul, César Viho

This is a Cifre contract (2015-2018) including a PhD thesis supervision (PhD of Imad Alawe), done with TDF, on the proposition of a scalable SDN-based mobile network architectures for the future 5G network.

8.4. Cifre contract on Personalization for Cognitive Autonomic Networks in 5G

Participants: César Viho

This is a Cifre contract (2017-2019) including a PhD thesis supervision (PhD of Illyyne Saffar), done with Nokia, on the proposition to use machine learning and data analytics to transform user and network data into actionable knowledge which in turn can be automatically exploited by Autonomic Networking approaches for cognitive self management of the 5G network.

8.5. Bilateral Contract with Industry: ALSTOM-Inria Common Lab

Participants: Bruno Tuffin, Gerardo Rubino

Bruno Tuffin is the co-director of ALSTOM-Inria common Lab.

The group currently manages a project with ALSTOM on system availability simulation taking into account logistic constraints. Current ALSTOM Transport and Power contracts, especially service-level agreements, impose stringent system availability objectives. Non-adherence to the required performance levels often leads to penalties, and it is therefore critical to assess the corresponding risks already at a tender stage. The challenge is to achieve accurate results in a reasonable amount of time. Monte Carlo simulation provides estimates of the quantities it is desired to predict (e.g., availability). Since we deal with rare events, variance reduction techniques, specifically Importance Sampling (IS) here, is used. The goal of the project is to establish the feasibility of IS for solving problems relevant to ALSTOM and to develop the corresponding mathematical tools.

8.6. Bilateral Contract with Industry: ADR Nokia Bell Labs

Participants: Yassine Hadjadj-Aoul, Gerardo Rubino

Gerardo Rubino is the coordinator of the reasearch action, named "Analytics and machine learning", with Nokia Bell Labs.

The objective is to carry out common research on an integrated framework for 5G, programmable networks, IoT and clouds that aims at statically and dynamically managing and optimizing the 5G infrastructure using, in particular, machine learning techniques.

<p style="text-align:center">**DIVERSE Project-Team**</p>

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. GLOSE

- Partners: Inria/CNRS/Safran
- Dates: 2017-2021
- Abstract: The GLOSE project develops new techniques for heterogeneous modeling and simulation in the context of systems engineering. It aims to provide formal and operational tools and methods to formalize the behavioral semantics of the various modeling languages used at system-level. These semantics will be used to extract behavioral language interfaces supporting the definition of coordination patterns. These patterns, in turn, can systematically be used to drive the coordination of any model conforming to these languages. The project is structured according to the following tasks: concurrent xDSML engineering, coordination of discrete models, and coordination of discrete/continuous models. The project is funded in the context of the network DESIR, and supported by the GEMOC initiative.

8.1.2. One Shot Software (OSS)

- Partners: Inria/Orange
- Dates: 2017-2019
- Abstract: The OSS project investigates an extreme version of moving target defense where a slightly different version of the application is deployed each time it is used (e.g., for crypto functions or payment services). We investigate the analysis, synthesis and transformation techniques to support diversification at 5 points of a software construction pipeline, which, once combined yield up to billions of variants. We also evaluate the support of diversification as a first class property in DevOps.

<p align="center" style="color:red">**KERDATA Project-Team**</p>

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. Huawei: HIRP Low-Latency Storage for Stream Data (2016–2017)
Participants: Alexandru Costan, Ovidiu-Cristian Marcu, Gabriel Antoniu.

The goal of this project is to explore the plausible paths towards a dedicated storage solution for low-latency stream storage. Such a solution should provide on the one hand traditional storage functionality and on the other hand stream-like performance (i.e., low-latency I/O access to items and ranges of items).

We have investigated the main requirements and challenges, evaluated the different design choices (e.g., a standalone component vs. an extension of an existing Big Data solution like HDFS) and proposed a new converged architecture for smart storage.

7.1.2. Total: In situ Visualization with Damaris (2017-2018).
Participants: Hadi Salimi, Matthieu Dorier, Gabriel Antoniu, Luc Bougé.

The goal of this expertise contract is to 1) disseminate the usage of Damaris for engineers at Total; 2) to realize a feasibility study for the usage of Damaris for in situ analysis of data for Total's HPC simulations.

<p style="text-align:center;color:red;">MYRIADS Project-Team</p>

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. Technicolor (2016-2017)

Participant: Guillaume Pierre.

Our collaboration with Technicolor has focused on the design of a scalable and elastic virtual customer premises equipment based on Network Function Virtualization, Software-Defined Networking and Cloud technologies. In 2017 we completed the system design and started implementing the system. The collaboration completed successfully in June 2017. However, the vCPE project within which this collaboration took place was unfortunately interrupted by Technicolor before we could write a paper about this work.

8.2. Bilateral Grants with Industry

8.2.1. Thales Research and Technology (2016-2018)

Participants: Baptiste Goupille-Lescar, Christine Morin, Nikos Parlavantzas.

Our collaboration with Thales Research and Technology focuses on the development of distributed Cyber-Physical Systems, such as those developed by Thales to monitor and react to changing physical environments. These systems need to be highly adaptable in order to cope with the dynamism and diversity of their operating environments. Notably, they require distributed, parallel architectures that support dynamic sets of applications, not known in advance, while providing strong QoS guarantees. The objective of this collaboration is to explore adaptive resource management mechanisms for such systems that can adapt to changes in the requirements and in the availability of resources. This contract funds Baptiste Goupille-Lescar's PhD grant.

8.2.2. Nokia (2015-2018)

Participant: Christine Morin.

Together with CIDRE Inria project-team we are involved in a collaboration with Nokia on security policy adaptation driven by risk evaluation in modern communication infrastructures. To address the need for efficient security supervision mechanisms, approaches such as attack graphs generation, coupled to a risk-based assessment have been used to provide an insight into a system's threat exposure. In comparison to static infrastructures, clouds exhibit a dynamic nature and are exposed to new attack scenarios due to virtualization. The goal of this collaboration is thus to revisit existing methods in the context of clouds. This contract funds Pernelle Mensah's PhD grant. Pernelle is a member of CIDRE project-team.

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

Project: SIMHet

Partner: YoGoKo

Starting: Nov 2015; Ending : October 2018

Contact: JM Bonnin

Abstract: The SIMHet project is performed in partnership with YoGoKo, a start-up that develops innovative communication solutions for cooperative intelligent transport systems. The SIMHet project aims to develop a decision making mechanism that would be integrated in the ISO/ETSI ITS communication architecture. It will allow mobile devices or mobile routers to choose the best network interface for each embedded application/flow. For example, in a vehicular environment this mechanism could manage global (Internet) and local connections for each on board device/application, in order to ensure that applications and services are always best connected. Aware that "best" concept is context-dependent, such a decision making mechanism should take into account requirements from different actors (e.g., applications, user, network administrators) and contextual information. One of the difficulties is to take advantage of the knowledge the system could have about near future connectivity. In the vehicular context such information about the movement and the availability of network resources is available. If taking into account the future makes the decision making more complex, this could allow a better usage of network resources when they are available. Once current solutions in the market are based on very simple decisions (use WiFi if available and 3G elsewhere), this smart mechanism will give competitive advantage for YoGoKo over its competitors.

<center>**HYBRID Project-Team**</center>

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. *Mensia Technologies*

Participants: Anatole Lécuyer, Jussi Tapio Lindgren.

Mensia Technologies is an Inria start-up company created in November 2012 as a spin-off of Hybrid team. Mensia is focused on wellness and healthcare applications emerging from the BCI and Neurofeedback technologies. The Mensia startup should benefit from the team's expertise and of valuable and proprietary BCI research results. Mensia is based in Rennes and Paris. Anatole Lécuyer and Yann Renard (former Inria expert engineer who designed the OpenViBE software architecture and was involved in team projects for 5 years) are co-founders of Mensia Technologies together with CEO Jean-Yves Quentel.

The on-going contract between Hybrid and Mensia started in November 2013 and supports the transfer of several softwares designed by Hybrid team ("OpenViBE", "StateFinder") related to our BCI activity to Mensia Technologies for multimedia or medical applications of Mensia.

8.2. Bilateral Grants with Industry

8.2.1. *Technicolor*

Participants: Antoine Costes, Anatole Lécuyer, Ferran Argelaguet.

This grant started in December 2015. It supports Antoine Costes's CIFRE PhD program with Technicolor company on "Haptic Texturing".

8.2.2. *Realyz*

Participants: Guillaume Cortes, Anatole Lécuyer.

This grant started in December 2015. It supports Guillaume Cortes's CIFRE PhD program with Realyz company on "Improving tracking in VR".

8.2.3. *VINCI Construction*

Participants: Anne-Solène Dris-Kerdreux, Bruno Arnaldi, Valérie Gouranton.

This grant started in November 2015. It supports Anne-Solene Dris-Kerdreux's CIFRE PhD program with Vinci company on "Training in VR for construction applications".

8.2.4. *Orange Labs*

Participants: Guillaume Bataille, Bruno Arnaldi, Valérie Gouranton.

This grant started in October 2017. It supports Guillaume Bataille's PhD program with Orange Labs company on "Natural Interactions with IoT using VR/AR".

<p align="center" style="color:red">LACODAM Project-Team</p>

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. ITRAMI: Interactive Trace Mining

Participant: Alexandre Termier.

ITRAMI is a Nano2017 project. Such projects are designed to support joint research efforts between STMicrolectronics and academic partners in the domain of embedded systems. Alexandre Termier is the PI of this project whose goal is to design novel data mining methods for interactive analysis of execution traces. Such methods aim at considerably reducing the time that STMicroelectronics developers spend at understanding, debugging and profiling applications running on STMicrolectronics chips. The work is done at University Grenoble Alps, in collaboration with LACODAM researchers. Two contractual staff members are working on the project in Grenoble: Willy Ugarte as postdoc, and Soumaya Ben Alouane as engineer.

8.1.2. Hyptser: Hybrid Prediction of Time-Series

Participants: Thomas Guyet, Vincent Lemaire [Orange Labs], Simon Malinowski [LinkMedia].

HYPTSER is a project funded by the Gaspard Monge Program for Optimisation and Operational Research (PGMO). It is dedicated to the development of innovative methods for predictions in time series. In the field of machine learning, *ensemble methods* have gained popularity in the last years. These methods combine several algorithms that solve the same task in order to improve the performance of the outcome. Two main families of ensemble methods can be found in the literature : The first family makes use of different models and combine their results a posteriori. The methods Bagging and Boosting are examples of methods in this family [26], [34]. The second family is based on a smart selection of the local algorithms in order to create a global hybrid algorithm. Logistic Model Tree [30] or Extreme Learning Machine Tree [36] are examples of such hybrid algorithms. In this project, starting at the end of 2017 for one year, we envision to explore the second family of methods in order to analyze how efficiently hybrid models can perform on the task of time series prediction. We plan to apply these methods to predict resource usage for cloud computing (CPU, memory) so as to minimize their infrastructure.

8.1.3. Particular Contract of the Strategic Action EDF/Inria

Participants: Manel Boumghar [EDF R&D], Laurent Pierre [EDF R&D], Thomas Guyet, René Quiniou.

The analysis of customer pathways has become a strategic issue for many businesses. The interaction traces left by clients when connecting to the customer services can be combined with data from other communication channels (phone, web form, e-mail, mail, fax, SMS, shop, etc.) and allow to analyse the customer pathways in details.

Pattern mining tools are able to extract the frequent customer behaviors in very large databases of client pathways. Nevertheless, taking into account the duration and the delay between the customer actions in the mining remains a challenge. The objective of this one-year contract was to design and develop a frequent mining tool that accounts for temporal patterns with negations for analysis of multichannel customer pathways. In this line, we developed and implemented the NTGSP algorithm [17].

8.2. Bilateral Grants with Industry

Maël Guillemé has obtained a CIFRE PhD grant with the Energiency startup, supervised by V. Masson and L. Rozé. The goal of Maël's thesis is to propose new approaches to improve industrial energy performance by integrating both numerical and symbolic attributes. An M2 internship from 2016 explored an approach based on an algorithm proposed by Shokoohi and al,. and proposed several improvements: avoid data normalisation, detect patterns as fast as possible, enhance functions like distance and score.

Another CIFRE thesis has started, this time with the Amossys company, which specializes in cyber-security. This is the PhD of Alban Siffer, located in the EMSEC team of IRISA and co-supervised between EMSEC (P.A. Fouque) and LACODAM (A. Termier, C. Largouët). The goal of this PhD is to propose new methods for intrusion detection in networks. The novel insight is to consider only IP flow as input (metadata of packets and not packet contents) and detect intrusion via unusual traffic patterns.

On October 2017, Colin Leverger started a thesis funded by Orange and co-supervised between Orange Labs (R. Marguerie), LACODAM (A. Termier, T. Guyet) and LinkMedia (S. Malinowski). The goal of this thesis is to propose new methods to forecast time series in order to support capacity planning tasks.

Elisa Fromont is still involved in the supervision of two PhD students through her former employer: the University of Saint-Etienne. One of the students is Guillaume Metzler, who works with the sponsorship of the Blitz company on bank fraud detection. On the other hand, Kevin Bascol (financed by a FUI project) works in collaboration with Bluecime (Grenoble) and works on improving ski-lift security.

<p style="text-align:center;color:red;">LAGADIC Project-Team</p>

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. *Robocortex*

Participants: Souriya Trinh, Fabien Spindler, François Chaumette.

no Inria Rennes 11369, duration: 20 months.

This contract with the Inria Robocortex start up in Sophia-Antipolis started in September 2016. It is devoted to provide our expertise in visual tracking for an application specified by Dassault Aviation.

8.1.2. *ABB*

Participants: Souriya Trinh, Fabien Spindler, François Chaumette.

no Inria Rennes 12597, duration: 8 months.

This contract with ABB in Barcelona started in September 2017. It is devoted to provide our expertise in visual tracking and visual servoing for an industrial application.

8.1.3. *IRT b<>com*

Participants: Hadrien Gurnel, Fabien Spindler, Alexandre Krupa.

no Inria Rennes 11774, duration: 36 months.

This contract started in October 2016 and concerns the leasing to IRT b<>com of two modules of the Lagadic medical robotic platform. Each module is rent 40 days during a 3-year period in the context of the IRT b<>com NeedleWare project (see Section 9.1.7).

8.2. Bilateral Grants with Industry

8.2.1. *Technicolor*

Participants: Salma Jiddi, Eric Marchand.

no Univ. Rennes 1 15CC310-02D, duration: 36 months.

This project funded by Technicolor started in October 2015. It supports Salma Jiddi's Ph.D. about augmented reality (see Section 7.1.9).

8.2.2. *Realyz*

Participant: Eric Marchand.

no Inria Rennes 10822, duration: 36 months.

This project funded by Realyz started in October 2015. It is achieved in cooperation with Anatole Lécuyer from Hybrid group at Irisa and Inria Rennes-Bretagne Atlantique to support Guillaume Cortes Ph.D. about motion tracking in virtual reality.

8.2.3. *Pôle Saint Hélier*

Participants: Louise Devigne, Marie Babel.

no Insa Rennes 2015/0890, duration: 36 months.

This project started in November 2015. It addresses the following two issues. First, the idea is to design a low-cost indoor / outdoor efficient obstacle avoidance system that respects the user intention, and does not alter user perception. This involves embedding innovative sensors to tackle the outdoor wheelchair navigation problem. The second objective is to take advantage of the proposed assistive tool to enhance the user Quality of Experience by means of biofeedback as well as the understanding of the evolution of the pathology.

8.2.4. *Axyn*

Participants: Dayana Hassan, Paolo Salaris, Patrick Rives.

no Inria Sophia 10874-1, duration: 36 months.

The objective of this project that started in November 2016 is to explore new methodologies for the interaction between humans and robots, autonomous navigation and mapping and to transfer the results obtained on the robotic platform developed by AXYN for assisting disabled/elderly people at home or in hospital structures. Cost limits, good accessibility to aged people, robustness and safety related to the applications are at the heart of the project. This contract (ANRT-CIFRE) support Dayana Hassan's Ph.D (see Section 7.5.6).

LINKMEDIA Project-Team

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

Quai des Apps: one-shot 2-day contract for scientific counseling on visual image retrieval.

<p align="center" style="color:red">MIMETIC Project-Team</p>

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. BPI-PCR Robo-KII

Participant: Armel Crétual [contact].

This contract has started in February 2017 and will last in October 2018. In M2S, it involves two permanent members of MimeTic team, Armel Crétual and Franck Multon, and two engineers, Antoine Marin (18 months grant) and Brice Bouvier (10 months grant).

This project is a collaboration between BA Healthcare and M2S lab. It aims at developing a robotics platform to allow physicians to start gait rehabilitation as soon as possible, even before patients are able to maintain upright posture alone. The usual way to perform such rehab sessions is to make the patient walk on a treadmill benefiting from a harness to prevent patient from falling. The two main limits of this approach are that:

- only straightforward at constant speed gaits are feasible whereas falling risks are much higher when modifying speed or turning
- walking on a treadmill when motor abilities are very affected can be challenging and can generate strong apprehension.

In a previous project, Robo-K, ended in september 2016, BA Healthcare has developed a first prototype of a mobile robot which strongly modified the approach: the harness is mobile and follows the patient displacement. In this way, the patient walks on the ground at his/her desired speed and the physician can include curved trajectories in the rehab process.

The main novelty of Robo-KII project is to implement a biofeeedback system onto the robotics platform to reinforce rehab sessions. Closely working with physicians from two PMR services, CHU Rennes and Kerpape center, we intend to define the optimal feedback to be given to the patients and to measure the corresponding gait parameters thanks to depth cameras mounted on the robot.

8.2. Bilateral Grants with Industry

Participants: Marc Christie, Christophe Lino.

Bilateral contract with Technicolor on empowering drones with cinematographics knowledge. Participants: Philippe Guillotel, Julien Fleureau, Quentin Galvane. Amount 25kE. Duration 24 months.

<p style="text-align:center">**PANAMA Project-Team**</p>

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Grants with Industry

8.1.1. CIFRE contract with Technicolor R&I France on Very large scale visual comparison
Participants: Rémi Gribonval, Himalaya Jain.

> *Duration: 3 years (2015-2018)*
>
> *Research axis:* *3.1.2*
>
> *Partners: Technicolor R&I France; Inria-Rennes*
>
> *Funding: Technicolor R&I France; ANRT*

The grand goal of this thesis is to design, analyze and test new tools to allow large-scale comparison of high-dimensional visual signatures. Leveraging state of the art visual descriptors, the objective is to obtain new compact codes for visual representations, exploiting sparsity and learning, so that they can be stored and compared in an efficient, yet meaningful, way.

<p style="text-align: center; color: red;">**SIROCCO Project-Team**</p>

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

8.1.1. *CIFRE contract with Envivio/ Ericsson on LDR compatible HDR video coding*
Participants: Christine Guillemot, David Gommelet, Aline Roumy.

- Title : LDR-compatible coding of HDR video signals.
- Partners : Envivio.
- Funding : Cifre Envivio/Ericsson.
- Period : Oct.2014-Sept.2017.

The goal of this Cifre contract is to design solutions for LDR-compatible coding of HDR videos. This involves the study of rate-distortion optimized tone mapping operators taking into account constraints of temporal coherency to avoid the temporal flickering which results from a direct frame-by-frame application of classical tone mapping operators. The goal is also to design a coding architecture which will build upon these operators, integrating coding tools tailored to the statistics of the HDR refinement signals.

8.1.2. *CIFRE contract with Harmonic on image analysis for HDR video compression*
Participants: Maxime Rousselot, Olivier Le Meur.

- Title : image and video analysis for HDR video compression
- Partners : Harmonic, Univ. Rennes 1
- Funding: Harmonic, ANRT
- Period: April 2016-April 2019

This project (in collaboration with Rémi Cozot, FRVSense) aims to investigate two main axes. First, we want to assess whether the representation of High Dynamic Range signal has an impact on the coding efficiency. We will focus mainly on the Hybrid Log-Gamma (HLG) and Perceptual Quantizer (PQ) OETF (Opto-Electronic Transfer Function)approaches. The former defines a nonlinear transfer function which is display-independent and able to produce high quality images without compromising the director's artistic intent. The latter approach is based on Just Noticeable Difference curve. If it turns out that this representation has an impact, the coding strategy should be adjusted with respect to the representation. In addition, specific preprocessing tools will be defined to deal with the limitations of PQ and HLG approaches.

8.1.3. *CIFRE contract with Technicolor on image collection analysis*
Participants: Dmitry Kuzovkin, Olivier Le Meur.

- Title : Spatiotemporal retargeting and recomposition based on artistic rules
- Partners : Technicolor, Univ. Rennes 1
- Funding: Technicolor, ANRT
- Period: Nov. 2015 – Nov. 2018

The goal of the project (in collaboration with Rémi Cozot, FRVSense) is to take advantage of the huge quantities of image and video data currently available - captured by both amateur and professional users - as well as the multiple copies of each scene that users often capture, to improve the aesthetic appeal of content. Additionally, given Technicolor's unique position, we propose to take advantage of insights as well as content from professional artists and colorists to learn how different content types can be enhanced.

8.1.4. CIFRE contract with Technicolor on light fields editing

Participants: Christine Guillemot, Matthieu Hog.

- Title : Light fields editing
- Research axis : 7.1.5
- Partners : Technicolor, Inria-Rennes.
- Funding : Technicolor, ANRT.
- Period : Oct.2015-Sept.2018.

Editing is quite common with classical imaging. Now, if we want light-fields cameras to be in the future as common as traditional cameras, this functionality should also be enabled with light-fields. The goal of the PhD is to develop methods for light-field editing, and in 2017 we have introduced the the concept of super-ray which is a grouping of rays within and across views, and developed a fast algorithm for super-ray construction(see section 7.1.5).

8.1.5. CIFRE contract with Technicolor on light fields compressed representation

Participants: Christine Guillemot, Fatma Hawary.

- Title : Light fields compressed representation
- Research axis : 7.2.5
- Partners : Technicolor, Inria-Rennes.
- Funding : Technicolor, ANRT.
- Period : Feb.2016-Jan.2019.

The goal of this PhD is to study reconstruction algorithms from compressed measurements based on the assumption of sparsity in the Fourier domain. The goal is to apply these algorithms to scalable compression of light fields.

8.1.6. CIFRE contract with Technicolor on cloud-based image compression

Participants: Jean Begaint, Christine Guillemot.

- Title : Cloud-based image compression
- Research axis : 7.2.1
- Partners : Technicolor, Inria-Rennes.
- Funding : Technicolor, ANRT.
- Period : Nov.2015-Oct.2018.

The goal of this Cifre contract is to develop a novel image compression scheme exploiting similarity between images in a cloud. The objective will therefore be to develop rate-distortion optimized affine or homographic estimation and compensation methods which will allow us to construct prediction schemes and learn adapted bases from most similar images retrieved by image descriptors. One issue to be addressed is the rate-distortion trade-off induced by the need for transmitting image descriptors.