



IN PARTNERSHIP WITH:  
**CNRS**

**Institut polytechnique de  
Grenoble**

**Université de Grenoble Alpes**

Activity Report 2017

# **Project-Team PERVASIVE INTERAC- TION**

## Pervasive Interaction

IN COLLABORATION WITH: Laboratoire d'Informatique de Grenoble (LIG)

RESEARCH CENTER  
**Grenoble - Rhône-Alpes**

THEME  
**Robotics and Smart environments**



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## Project-Team PERVASIVE INTERACTION

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### **Keywords:**

#### **Computer Science and Digital Science:**

- A1.2.5. - Internet of things
- A1.4. - Ubiquitous Systems
- A1.5.2. - Communicating systems
- A1.6. - Green Computing
- A2.3.1. - Embedded systems
- A2.6.2. - Middleware
- A3.4.1. - Supervised learning
- A3.4.2. - Unsupervised learning
- A3.4.3. - Reinforcement learning
- A3.4.5. - Bayesian methods
- A3.4.6. - Neural networks
- A3.4.8. - Deep learning
- A3.5.2. - Recommendation systems
- A5.1. - Human-Computer Interaction
- A5.3.3. - Pattern recognition
- A5.4. - Computer vision
- A5.4.1. - Object recognition
- A5.4.2. - Activity recognition
- A5.4.5. - Object tracking and motion analysis
- A5.4.6. - Object localization
- A5.6. - Virtual reality, augmented reality
- A5.7.1. - Sound
- A5.7.4. - Analysis
- A5.10.2. - Perception
- A5.10.3. - Planning
- A5.10.4. - Robot control
- A5.10.5. - Robot interaction (with the environment, humans, other robots)
- A5.10.7. - Learning
- A5.10.8. - Cognitive robotics and systems
- A5.11. - Smart spaces
- A5.11.1. - Human activity analysis and recognition
- A5.11.2. - Home/building control and interaction
- A9. - Artificial intelligence
- A9.1. - Knowledge
- A9.2. - Machine learning
- A9.3. - Signal analysis
- A9.5. - Robotics
- A9.7. - AI algorithmics

**Other Research Topics and Application Domains:**

- B1.2.2. - Cognitive science
- B2.1. - Well being
- B2.5.3. - Assistance for elderly
- B3.5. - Agronomy
- B4.5. - Energy consumption
- B4.5.1. - Green computing
- B4.5.2. - Embedded sensors consumption
- B5.6. - Robotic systems
- B6.4. - Internet of things
- B6.5. - Information systems
- B6.6. - Embedded systems
- B8.1. - Smart building/home
- B8.1.1. - Energy for smart buildings
- B8.1.2. - Sensor networks for smart buildings
- B8.2. - Connected city
- B9.1.1. - E-learning, MOOC
- B9.5.1. - Psychology
- B9.5.3. - Economy, Finance

## 1. Personnel

**Research Scientists**

- Sabine Coquillart [Inria, Senior Researcher, HDR]
- Thierry Fraichard [Inria, Researcher, HDR]
- Emmanuel Mazer [CNRS, Senior Researcher, HDR]

**Faculty Members**

- James Crowley [Team leader, Institut polytechnique de Grenoble, Professor, HDR]
- Patrick Reignier [Institut polytechnique de Grenoble, Professor, HDR]
- Dominique Vaufreydaz [Univ Grenoble Alpes, Associate Professor]
- Philippe Dessus [Univ Grenoble Alpes, Professor, HDR]

**Post-Doctoral Fellow**

- Marvin Faix [CNRS]

**PhD Students**

- Nachwa Abou Bakr [Univ Grenoble Alpes]
- Amr Al-Zouhri Al-Yafi [Univ Grenoble Alpes]
- Etienne Balit [Univ Grenoble Alpes, until Aug 2017]
- Matteo Ciocca [Univ Grenoble Alpes]
- Julien Cumin [Orange Labs]
- Jose Da Silva Filho [Univ Grenoble Alpes]
- Raphael Lambert Frisch [Univ Grenoble Alpes]
- Thomas Guntz [Inria]
- Remi Paulin [Univ Grenoble Alpes]
- Viet Cuong Ta [Hanoi Polytechnique Institut]

**Technical staff**

- Giovanni Balestrieri [Inria]

Raffaella Balzarini [Inria]  
Maxime Belgodere [Inria]  
Nicolas Bonnefond [Inria]  
Stanislaw Borkowski [Inria]  
Mustapha El Majihi [Inria, from Jun 2017 until Oct 2017]  
Remi Pincent [Inria]

**Interns**

Julien Alaimo [Inria, from Jun 2017 until Aug 2017]  
Daulet Bari [Inria, from Feb 2017 until Aug 2017]  
Lamia Benaouali [Inria, from Feb 2017 until Aug 2017]  
Lucas Bergeron [Inria, from Apr 2017 until Jul 2017]  
Gabriel Bouvier Denoix [Inria, until Jun 2017]  
Nour El Hoda Djidi [Inria, from Mar 2017 until Jul 2017]  
Mohammed Jazouani [Inria, from Apr 2017 until Jul 2017]  
Werner Madeleine [Inria, from May 2017 until Jun 2017]  
Vilma Muco [Inria, from Feb 2017 until Jun 2017]  
Quoc Trung Vuong [Inria, from Jul 2017 until Aug 2017]

**Administrative Assistants**

Alexandra Fitzgerald [Inria]  
Lydie Leon [Inria]

**Visiting Scientist**

Ivana Senk [Inria, Sep 2017]

**External Collaborator**

Joelle Coutaz [Univ Grenoble Alpes]

## 2. Overall Objectives

### 2.1. Overall Objectives

Pervasive Interaction develops theories and models for context aware, sociable interaction with systems and services that are dynamically composed from collections of interconnected smart objects. The project uses of situation models as a technological foundation for situated behavior for smart objects and services.

The research program for Pervasive Interaction is designed to respond to the following four research questions:

- Q1: What are the most appropriate computational techniques for acquiring and using situation models for situated behavior by smart objects?
- Q2: What perception and action techniques are most appropriate for situated interaction with smart objects?
- Q3: Can we use situation modelling as a foundation for sociable interaction with smart objects?
- Q4: Can we use situated smart objects as a form of immersive media?

The Pervasive Interaction team was initially formed as a provisional project team of the Inria Grenoble Rhone-Alpes Research Center in April 2016. In November 2017, Pervasive Interaction has been officially designated as an Inria project team. For technical reasons, some publications and results from November and December 2017 are excluded from this report.

## 3. Research Program

### 3.1. Situation Models

Situation Modelling, Situation Awareness, Probabilistic Description Logistics

The objectives of this research area are to develop and refine new computational techniques that improve the reliability and performance of situation models, extend the range of possible application domains, and reduce the cost of developing and maintaining situation models. Important research challenges include developing machine-learning techniques to automatically acquire and adapt situation models through interaction, development of techniques to reason and learn about appropriate behaviors, and the development of new algorithms and data structures for representing situation models.

Pervasive Interaction will address the following research challenges:

**Techniques for learning and adapting situation models:** Hand crafting of situation models is currently an expensive process requiring extensive trial and error. We will investigate combination of interactive design tools coupled with supervised and semi-supervised learning techniques for constructing initial, simplified prototype situation models in the laboratory. One possible approach is to explore developmental learning to enrich and adapt the range of situations and behaviors through interaction with users.

**Reasoning about actions and behaviors:** Constructing systems for reasoning about actions and their consequences is an important open challenge. We will explore integration of planning techniques for operationalizing actions sequences within behaviors, and for constructing new action sequences when faced with unexpected difficulties. We will also investigate reasoning techniques within the situation modeling process for anticipating the consequences of actions, events and phenomena.

**Algorithms and data structures for situation models:** In recent years, we have experimented with an architecture for situated interaction inspired by work in human factors. This model organises perception and interaction as a cyclic process in which directed perception is used to detect and track entities, verify relations between entities, detect trends, anticipate consequences and plan actions. Each phase of this process raises interesting challenges questions algorithms and programming techniques. We will experiment alternative programming techniques representing and reasoning about situation models both in terms of difficulty of specification and development and in terms of efficiency of the resulting implementation. We will also investigate the use of probabilistic graph models as a means to better accommodate uncertain and unreliable information. In particular, we will experiment with using probabilistic predicates for defining situations, and maintaining likelihood scores over multiple situations within a context. Finally, we will investigate the use of simulation as technique for reasoning about consequences of actions and phenomena.

**Probabilistic Description Logics:** In our work, we will explore the use of probabilistic predicates for representing relations within situation models. As with our earlier work, entities and roles will be recognized using multi-modal perceptual processes constructed with supervised and semi-supervised learning [Brdiczka 07], [Barraquand 12]. However, relations will be expressed with probabilistic predicates. We will explore learning based techniques to probabilistic values for elementary predicates, and propagate these through probabilistic representation for axioms using Probabilistic Graphical Models and/or Bayesian Networks.

The challenges in this research area will be addressed through three specific research actions covering situation modelling in homes, learning on mobile devices, and reasoning in critical situations.

### ***3.1.1. Learning Routine patterns of activity in the home.***

The objective of this research action is to develop a scalable approach to learning routine patterns of activity in a home using situation models. Information about user actions is used to construct situation models in which key elements are semantic representations of time, place, social role and actions. Activities are encoded as sequences of situations. Recurrent activities are detected as sequences of activities that occur at a specific time and place each day. Recurrent activities provide routines what can be used to predict future actions and anticipate needs and services. An early demonstration has been to construct an intelligent assistant that can respond to and filter communications.

This research action is carried out as part of the doctoral research of Julian Cumin in cooperation with researchers at Orange labs, Meylan. Results are to be published at Ubicomp, Ambient intelligence, Intelligent Environments and IEEE Transactions on System Man and Cybernetics. Julien Cumin will complete and defend his doctoral thesis in 2018.



### **3.1.2. Learning Patterns of Activity with Mobile Devices**

The objective of this research action is to develop techniques to observe and learn recurrent patterns of activity using the full suite of sensors available on mobile devices such as tablets and smart phones. Most mobile devices include seven or more sensors organized in 4 groups: Positioning Sensors, Environmental Sensors, Communications Subsystems, and Sensors for Human-Computer Interaction. Taken together, these sensors can provide a very rich source of information about individual activity.

In this area we explore techniques to observe activity with mobile devices in order to learn daily patterns of activity. We will explore supervised and semi-supervised learning to construct systems to recognize places and relevant activities. Location and place information, semantic time of day, communication activities, interpersonal interactions, and travel activities (walking, driving, riding public transportation, etc.) are recognized as probabilistic predicates and used to construct situation models. Recurrent sequences of situations will be detected and recorded to provide an ability to predict upcoming situations and anticipate needs for information and services.

Our goal is to develop a theory for building context aware services that can be deployed as part of the mobile applications that companies such as SNCF and RATP use to interact with clients. For example, a current project concerns systems that observe daily travel routines for the Paris region RATP metro and SNCF commuter trains. This system learns individual travel routines on the mobile device without the need to divulge information about personal travel to a cloud based system. The resulting service will consult train and metro schedules to assure that planned travel is feasible and to suggest alternatives in the case of travel disruptions. Similar applications are under discussion for the SNCF inter-city travel and Air France for air travel.

This research action is conducted in collaboration with the Inria Startup Situ8ed. The current objective is to deploy and evaluate a first prototype App during 2017. Techniques will be used commercially by Situ8ed for products to be deployed as early as 2019.

### **3.1.3. Observing and Modelling Competence and Awareness in Critical Situations**

The aim of this research action is to experimentally evaluate and compare current theories for mental modelling for problem solving and attention in stressful situations, as well as to refine theories and techniques for observing visual fixation, attention and emotion. We are currently investigating differences in visual attention, emotional response and mental states of chess experts and chess novices solving chess problems and participating in chess matches. We observe physiological responses, mental states and visual attention using eye-tracking, long term and instantaneous face-expressions (micro-expressions), skin conductivity, blood flow (BVP), posture and other information extracted from audio-visual recordings of players.

We expect that a high degree of expertise in chess should be reflected in patterns of eye movement and emotional reaction in accordance with the game situation. Information from visual attention will be used to determine and model the degree to which a player understands the game situation in terms of abstract configurations of chess pieces rather than the positions of individual pieces. Information about the emotional reactions of players will be expressed as trajectories in the physiological space of pleasure, arousal and dominance to determine if a player's understanding of the game situation can be observed from emotional reaction to game play.

This work is supported by the ANR project CEEGE in cooperation with the department of NeuroCognition of Univ. Bielefeld, as well as the LIG internal project AirBorne in cooperation with the French Air Force training center at ISTRE. Work in this area includes the Doctoral research of Thomas Guntz to be defended in 2019.

### **3.1.4. Bibliography**

[Brdiczka 07] O. Brdiczka, "Learning Situation Models for Context-Aware Services", Doctoral Thesis of the INPG, 25 May 2007.

[Barraquand 12] R. Barraquand, "Design of Sociable Technologies", Doctoral Thesis of the University Grenoble Alps, 2 Feb 2012.

## 3.2. Perception of People, Activities and Emotions

Machine perception is fundamental for situated behavior. Work in this area will concern construction of perceptual components using computer vision, acoustic perception, accelerometers and other embedded sensors. These include low-cost accelerometers [Bao 04], gyroscopic sensors and magnetometers, vibration sensors, electromagnetic spectrum and signal strength (wifi, bluetooth, GSM), infrared presence detectors, and bolometric imagers, as well as microphones and cameras. With electrical usage monitoring, every power switch can be used as a sensor [Fogarty 06], [Coutaz 16]. We will develop perceptual components for integrated vision systems that combine a low-cost imaging sensors with on-board image processing and wireless communications in a small, low-cost package. Such devices are increasingly available, with the enabling manufacturing technologies driven by the market for integrated imaging sensors on mobile devices. Such technology enables the use of embedded computer vision as a practical sensor for smart objects.

Research challenges to be addressed in this area include development of practical techniques that can be deployed on smart objects for perception of people and their activities in real world environments, integration and fusion of information from a variety of sensor modalities with different response times and levels of abstraction, and perception of human attention, engagement, and emotion using visual and acoustic sensors.

Work in this research area will focus on three specific Research Actions

### 3.2.1. *Multi-modal perception and modeling of activities*

The objective of this research action is to develop techniques for observing and scripting activities for common household tasks such as cooking and cleaning. An important part of this project involves acquiring annotated multi-modal datasets of activity using an extensive suite of visual, acoustic and other sensors. We are interested in real-time on-line techniques that capture and model full body movements, head motion and manipulation actions as 3D articulated motion sequences decorated with semantic labels for individual actions and activities with multiple RGB and RGB-D cameras.

We will explore the integration of 3D articulated models with appearance based recognition approaches and statistical learning for modeling behaviors. Such techniques provide an important enabling technology for context aware services in smart environments [Coutaz 05], [Crowley 15], investigated by Pervasive Interaction team, as well as research on automatic cinematography and film editing investigated by the Imagine team [Gandhi 13] [Gandhi 14] [Ronfard 14] [Galvane 15]. An important challenge is to determine which techniques are most appropriate for detecting, modeling and recognizing a large vocabulary of actions and activities under different observational conditions.

We will explore representations of behavior that encodes both temporal-spatial structure and motion at multiple levels of abstraction. We will further propose parameters to encode temporal constraints between actions in the activity classification model using a combination of higher-level action grammars [Pirsiavash 14] and episodic reasoning [Santofimia 14] [Edwards 14].

Our method will be evaluated using long-term recorded dataset that contains recordings of activities in home environments. This work will be reported in the IEEE Conference on Face and Gesture Recognition, IEEE transactions on Pattern Analysis and Machine Intelligence, (PAMI) et IEEE Transactions on Systems man and Cybernetics. This work is carried out in the doctoral research of Nachwa Abubakr in cooperation with Remi Ronfard of the Imagine Team of Inria.

### 3.2.2. *Perception with low-cost integrated sensors*

In this research action, we will continue work on low-cost integrated sensors using visible light, infrared, and acoustic perception. We will continue development of integrated visual sensors that combine micro-cameras and embedded image processing for detecting and recognizing objects in storage areas. We will combine visual and acoustic sensors to monitor activity at work-surfaces. Low cost real-time image analysis procedures will be designed that acquire and process images directly as they are acquired by the sensor.

Bolometric image sensors measure the Far Infrared emissions of surfaces in order to provide an image in which each pixel is an estimate of surface temperature. Within the European MIRTIC project, Grenoble startup, ULIS has created a relatively low-cost Bolometric image sensor (Retina) that provides small images of 80 by 80 pixels taken from the Far-infrared spectrum. Each pixel provides an estimate of surface temperature. Working with Schneider Electric, engineers in the Pervasive Interaction team had developed a small, integrated sensor that combines the MIRTIC Bolometric imager with a microprocessor for on-board image processing. The package has been equipped with a fish-eye lens so that an overhead sensor mounted at a height of 3 meters has a field of view of approximately 5 by 5 meters. Real-time algorithms have been demonstrated for detecting, tracking and counting people, estimating their trajectories and work areas, and estimating posture.

Many of the applications scenarios for Bolometric sensors proposed by Schneider Electric assume a scene model that assigns pixels to surfaces of the floor, walls, windows, desks or other items of furniture. The high cost of providing such models for each installation of the sensor would prohibit most practical applications. We have recently developed a novel automatic calibration algorithm that determines the nature of the surface under each pixel of the sensor.

Work in this area will continue to develop low-cost real time infrared image sensing, as well as explore combinations of far-infrared images with RGB and RGBD images.

### **3.2.3. *Observation of emotion from physiological responses in critical situations***

Recent research in Cognitive Science indicates that the human emotions result in physiological manifestations in the heart rate, skin conductance, skin color, body movements and facial expressions. It has been proposed that these manifestations can be measured by observation of skin color, body motions, and facial expressions and modeled as activation levels in three dimensions known as Valence, Arousal and Dominance. The goal of this project is to evaluate the effectiveness of visual and acoustic perception technique for measuring these physiological manifestations.

Experimental data will be collected by observing subjects engaged in playing chess. A special apparatus has been constructed that allows synchronized recording from a color camera, Kinect2 3D camera, and Tobii Eye Tracker of a player seated before a computer generated display of a chess board. The masters student will participate in the definition and recording of scenarios for recording test data, apply recently proposed techniques from the scientific literature for measuring emotions, and provide a comparative performance evaluation of various techniques. The project is expected to reveal the relative effectiveness of computer vision and other techniques for observing human emotions.

### **3.2.4. *Bibliography***

[Bao 04] L. Bao, and S. S. Intille. "Activity recognition from user-annotated acceleration data.", IEEE Pervasive computing. Springer Berlin Heidelberg, pp1-17, 2004.

[Fogarty 06] J. Fogarty, C. Au and S. E. Hudson. "Sensing from the basement: a feasibility study of unobtrusive and low-cost home activity recognition." In Proceedings of the 19th annual ACM symposium on User interface software and technology, UIST 2006, pp. 91-100. ACM, 2006.

[Coutaz 16] J. Coutaz and J.L. Crowley, A First-Person Experience with End-User Development for Smart Homes. IEEE Pervasive Computing, 15(2), pp.26-39, 2016.

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[Pirsiavash 14] Hamed Pirsiavash, Deva Ramanan, "Parsing Videos of Actions with Segmental Grammars", Computer Vision and Pattern Recognition, p.612-619, 2014.

[Edwards 14] C. Edwards. 2014, "Decoding the language of human movement". Commun. ACM 57, 12, 12-14, November 2014.

### 3.3. Sociable Interaction with Smart Objects

Reeves and Nass argue that a social interface may be the truly universal interface [Reeves 98]. Current systems lack ability for social interaction because they are unable to perceive and understand humans or to learn from interaction with humans. One of the goals of the research to be performed in Pervasive Interaction is to provide such abilities.

Work in research area RA3 will demonstrate the use of situation models for sociable interaction with smart objects and companion robots. We will explore the use of situation models as a representation for sociable interaction. Our goal in this research is to develop methods to endow an artificial agent with the ability to acquire social common sense using the implicit feedback obtained from interaction with people. We believe that such methods can provide a foundation for socially polite man-machine interaction, and ultimately for other forms of cognitive abilities. We propose to capture social common sense by training the appropriateness of behaviors in social situations. A key challenge is to employ an adequate representation for social situations.

Knowledge for sociable interaction will be encoded as a network of situations that capture both linguistic and non-verbal interaction cues and proper behavioral responses. Stereotypical social interactions will be represented as trajectories through the situation graph. We will explore methods that start from simple stereotypical situation models and extending a situation graph through the addition of new situations and the splitting of existing situations. An important aspect of social common sense is the ability to act appropriately in social situations. We propose to learn the association between behaviors and social situation using reinforcement learning. Situation models will be used as a structure for learning appropriateness of actions and behaviors that may be chosen in each situation, using reinforcement learning to determine a score for appropriateness based on feedback obtained by observing partners during interaction.

Work in this research area will focus on four specific Research Actions

#### 3.3.1. *Moving with people*

Our objective in this area is to establish the foundations for robot motions that are aware of human social situation that move in a manner that complies with the social context, social expectations, social conventions and cognitive abilities of humans. Appropriate and socially compliant interactions require the ability for real time perception of the identity, social role, actions, activities and intents of humans. Such perception can be used to dynamically model the current situation in order to understand the situation and to compute the appropriate course of action for the robot depending on the task at hand.

To reach this objective, we propose to investigate three interacting research areas:

- Modeling the context and situation of human activities for motion planning
- Planning and acting in a social context.
- Identifying and modeling interaction behaviors.

In particular, we will investigate techniques that allow a tele-presence robot, such as the BEAM system, to autonomously navigate in crowds of people as may be found at the entry to a conference room, or in the hallway of a scientific meeting. We will also continue experiments on autonomous motion for personal assistance robots (project PRAMAD). Work in this area includes the doctoral work of Josã da Silva, to be defended in 2019.

### ***3.3.2. Understanding and communicating intentions from motion***

This research area concerns the communication through motion. When two or more people move as a group, their motion is regulated by implicit rules that signal a shared sense of social conventions and social roles. For example, moving towards someone while looking directly at them signals an intention for engagement. In certain cultures, subtle rules dictate who passes through a door first or last. When humans move in groups, they implicitly communicate intentions with motion. In this research area, we will explore the scientific literature on proxemics and the social sciences on such movements, in order to encode and evaluate techniques for socially appropriate motion by robots.

### ***3.3.3. Socially aware interaction***

This research area concerns socially aware man-machine interaction. Appropriate and socially compliant interaction requires the ability for real time perception of the identity, social role, actions, activities and intents of humans. Such perception can be used to dynamically model the current situation in order to understand the context and to compute the appropriate course of action for the task at hand. Performing such interactions in manner that respects and complies with human social norms and conventions requires models for social roles and norms of behavior as well as the ability to adapt to local social conventions and individual user preferences. In this research area, we will complement research area 3.2 with other forms of communication and interaction, including expression with stylistic face expressions rendered on a tablet, facial gestures, body motions and speech synthesis. We will experiment with use of commercially available tool for spoken language interaction in conjunction with expressive gestures.

### ***3.3.4. Stimulating affection and persuasion with affective devices.***

This research area concerns technologies that can stimulate affection and engagement, as well as induce changes in behavior. When acting as a coach or cooking advisor, smart objects must be credible and persuasive. One way to achieve this goal is to express affective feedbacks while interacting. This can be done using sound, light and/or complex moves when the system is composed of actuators.

Research in this area will address 3 questions:

1. How do human perceive affective signals expressed by smart objects (including robots)?
2. How does physical embodiment effect perception of affect by humans?
3. What are the most effective models and tools for animation of affective expression?

Both the physical form and the range of motion have important impact on the ability of a system to inspire affection. We will create new models to propose a generic animation model, and explore the effectiveness of different forms of motion in stimulating affect.

### ***3.3.5. Bibliography***

[Reeves 98] B. Reeves and C. Nass, *The Media Equation: how People Treat Computers, Television, and New Media Like Real People and Places*. Cambridge University Press, 1998.

## **3.4. Interaction with Pervasive Smart Objects and Displays**

Currently, the most effective technologies for new media for sensing, perception and experience are provided by virtual and augmented realities [Van Krevelen 2010]. At the same time, the most effective means to augment human cognitive abilities are provided by access to information spaces such as the world-wide-web using graphical user interfaces. A current challenge is to bring these two media together.

Display technologies continue to decrease exponentially, driven largely by investment in consumer electronics as well as the overall decrease in cost of microelectronics. A consequence has been an increasing deployment of digital displays in both public and private spaces. This trend is likely to accelerate, as new technologies and growth in available communications bandwidth enable ubiquitous low-cost access to information and communications.

The arrival of pervasive displays raises a number of interesting challenges for situated multi-modal interaction. For example:

1. Can we use perception to detect user engagement and identify users in public spaces?
2. Can we replace traditional pointing hardware with gaze and gesture based interaction?
3. Can we tailor information and interaction for truly situated interaction, providing the right information at the right time using the right interaction modality?
4. How can we avoid information overload and unnecessary distraction with pervasive displays?

It is increasingly possible to embed sensors and displays in clothing and ordinary devices, leading to new forms of tangible and wearable interaction with information. This raises challenges such as

1. What are the tradeoffs between large-scale environmental displays and wearable displays using technologies such as e-textiles and pico-projector?
2. How can we manage the tradeoffs between implicit and explicit interaction with both tangible and wearable interaction?
3. How can we determine the appropriate modalities for interaction?
4. How can we make users aware of interaction possibilities without creating distraction?

In addition to display and communications, the continued decrease in microelectronics has also driven an exponential decrease in cost of sensors, actuators, and computing resulting in an exponential growth in the number of smart objects in human environments. Current models for systems organization are based on centralized control, in which a controller or local hub, orchestrates smart objects, generally in connection with cloud computing. This model creates problems with privacy and ownership of information. An alternative is to organize local collections of smart objects to provide distributed services without the use of a centralized controller. The science of ecology can provide an architectural model for such organization.

This approach raises a number of interesting research challenges for pervasive interaction:

1. Can we devise distributed models for multi-modal fusion and interaction with information on heterogeneous devices?
2. Can we devise models for distributed interaction that migrates over available devices as the user changes location and task?
3. Can we manage migration of interaction over devices in a manner that provides seamless immersive interaction with information, services and media?
4. Can we provide models of distributed interaction that conserve the interaction context as services migrate?

Research Actions for Interaction with Pervasive Smart Objects for the period 2017 - 2020 include

### ***3.4.1. Situated interaction with pervasive displays***

The emergence of low-cost interactive displays will enable a confluence of virtual and physical environments. Our goal in this area is to go beyond simple graphical user interfaces in such environments to provide immersive multi-sensorial interaction and communication. A primary concern will be interaction technologies that blend visual with haptic/tactile feedback and 3D interaction and computer vision. We will investigate the use of visual-tactile feedback as well as vibratory signals to augment multi-sensorial interaction and communication. The focus will be on the phenomena of immersive interaction in real worlds that can be made possible by the blending of physical and virtual in ordinary environments.

### ***3.4.2. Wearable and tangible interaction with smart textiles and wearable projectors***

Opportunities in this area result from the emergence of new forms of interactive media using smart objects. We will explore the use of smart objects as tangible interfaces that make it possible to experience and interact with information and services by grasping and manipulating objects. We will explore the use of sensors and actuators in clothing and wearable devices such as gloves, hats and wrist bands both as a means of unobtrusively sensing human intentions and emotional states and as a means of stimulating human senses through vibration and sound. We will explore the new forms of interaction and immersion made possible by deploying interactive displays over large areas of an environment.

### **3.4.3. Pervasive interaction with ecologies of smart objects in the home**

In this research area, we will explore and evaluate interaction with ecologies of smart objects in home environments. We will explore development of a range of smart objects that provide information services, such as devices for Episodic Memory for work surfaces and storage areas, devices to provide energy efficient control of environmental conditions, and interactive media that collect and display information. We propose to develop a new class of socially aware managers that coordinate smart objects and manage logistics in functional areas such as the kitchen, living rooms, closets, bedrooms, bathroom or office.

### **3.4.4. Bibliography**

[Van Krevelen 10] D. W. F. Van Krevelen and R. Poelman, A survey of augmented reality technologies, applications and limitations. *International Journal of Virtual Reality*, 9(2), 1, 2010

## **4. Application Domains**

### **4.1. Smart Energy Systems**

Participants: Amr Alyafi, Amine Awada, Patrick Reignier Partners: UMR G-SCOP, UMR LIG (Persuasive Interaction, IIHM), CEA Liten, PACTE, Vesta Systems and Elithis.

Work in this area explores techniques for a user centric energy management system, where user needs and tacit knowledge drive the search of solutions. These are calculated using a flexible energy model of the living areas. The system is personified by energy consultants with which building actors such as building owners, building managers, technical operators but also occupants, can interact in order to co-define energy strategies, benefiting of both assets: tacit knowledge of human actors, and measurement with computation capabilities of calculators. Putting actors in the loop, i.e. making energy not only visible but also controllable is the needed step before large deployment of energy management solutions. It is proposed to develop interactive energy consultants for all the actors, which are energy management aided systems embedding models in order to support the decision making processes. MIRROR (interactive monitoring), WHAT-IF (interactive quantitative simulation), EXPLAIN (interactive qualitative simulation), SUGGEST-AND-ADJUST (interactive management) and RECOMMEND (interactive diagnosis) functionalities will be developed.

### **4.2. E-Textile**

Participant: Sabine Coquillart

Partner: LIMSI

Collaboration with the HAPCO team from LIMSI on e-textiles. A patent application has been filed related to this work:

- F. Bimbard, M. Bobin, M. Ammi, S. Coquillart "Procédé de conception d'un capteur de flexion textile piézorésistif à partir de fils fonctionnels", Patent Application, 2017.

### **4.3. Interaction with Pervasive Media**

Participants: Sabine Coquillart, Jingtao Chen

Partners: Inria GRA, GIPSA, G-SCOP

Pseudo-haptic feedback is a technique aiming to simulate haptic sensations without active haptic feedback devices. Pseudo-haptic techniques have been used to simulate various haptic feedbacks such as stiffness, torques, and mass. In the framework of Jingtao Chen PhD thesis, a novel pseudo-haptic experiment has been set up. The aim of this experiment is to study the EMG signals during a pseudo-haptic task. A stiffness discrimination task similar to the one published in Lecuyer's PhD thesis has been chosen. The experimental set-up has been developed, as well as the software controlling the experiment. Pre-tests are under way. They will be followed by the tests with subjects.

## 4.4. Bayesian Reasoning

Participants: Emmanuel Mazer, Marvin Faix

The development of modern computers is mainly based on increase of performances and decrease of size and energy consumption, with no notable modification of the basic principles of computation. In particular, all the components perform deterministic and exact operations on sets of binary signals. These constraints obviously impede further sizable progresses in terms of speed, miniaturization and power consumption. The main goal of the project MicroBayes is to investigate a radically different approach, using stochastic bit streams to perform computations. The aim of this project is to show that stochastic architectures can outperform standard computers to solve complex inference problems both in terms of execution speed and of power consumption. We will demonstrate the feasibility on two applications involving low level information processing from sensor signals, namely sound source localization and separation.

## 5. New Software and Platforms

### 5.1. DomiCube

- Participant: Rémi Pincent
- Contact: Rémi Pincent

### 5.2. EmoPRAMAD

KEYWORDS: Health - Home care

FUNCTIONAL DESCRIPTION: Within the Pramad project, we want to offer a full affective loop between the companion robot and the elderly people at home. This affective loop is necessary within the context of everyday interaction of elderly and the companion robot. A part of this loop is to make the robot express emotions in response to the emotional state of the user. To do that, we need to test our working hypothesis about the visual representation of emotions with the 3D face of robot. EmoPRAMAD is an evaluation tool designed to conduct comparative studies between human faces and the 3D faces expressing a defined set of emotions.

The evaluation conducted through EmoPRAMAD concerns both unimodal (facial only) and bimodal conditions (facial/sound). The emotions set is composed of 4 basic emotions (joy, fear, anger, sadness) and a neutral state. While experimenting, the software collects several parameters in order to evaluate more than correctness of the answers: time to respond, length of mouse moves, etc.

- Contact: Dominique Vaufreydaz

### 5.3. Online Movie Director

- Participants: Dominique Vaufreydaz, James Crowley and Patrick Reignier
- Contact: Dominique Vaufreydaz

### 5.4. PALGate

KEYWORDS: Health - Home care - Handicap

- Contact: David Daney



## 5.5. PrimaCV

- Participants: Amaury Nègre, Claudine Combe, James Crowley, Lukas Rummelhard, Rémi Baraquand and Sergi Pujades-Rocamora
- Contact: Amaury Nègre

## 5.6. SmartEnergy

**FUNCTIONAL DESCRIPTION:** Inhabitants play a key role in buildings global energy consumption but it is difficult to involve them in energy management. Our objective is to make energy consumption visible by simulating inside a serious game the energy impact of inhabitants behaviours. A serious game is currently under development, coupling a 3D virtual environment and a building energy simulator. The 3D virtual environment is based on the JMonkey 3D engine. New houses can be easily imported using SweetHome 3D and Blender. The building energy simulator is EnergyPlus. The 3D engine and the energy engine are coupled using the Functional Mock-up Interface (FMI) standard. Using this standard will allow to easily switch between existing building energy simulators.

- Participant: Patrick Reignier
- Contact: Patrick Reignier

## 5.7. SmartServoFramework

- Participants: Dominique Vaufreydaz and Eméric Grange
- Contact: James Crowley

## 5.8. Unix Interface for InfraRed Sensor

- Author: Pierre Baret
- Contact: James Crowley

## 5.9. Platforms

The AmiQual4Home Innovation Factory is an open research facility for innovation and experimentation with human-centered services based on the use of large-scale deployment of interconnected digital devices capable of perception, action, interaction and communication. The Innovation Factory is composed of a collection of workshops for rapid creation of prototypes, surrounded by a collection of living labs and supported by an industrial innovation and transfer service. Creation of the Innovation Factory has been made possible by a grant from French National programme Investissement d'avenir, together with substantial contributions of resources by Grenoble INP, Univ Joseph Fourier, UPMF, CNRS, Schneider Electric and the Communauté de Communes de Montbonnot. The objective is to provide the academic and industrial communities with an open platform to enable research on design, integration and evaluation of systems and services for smart habitats.

The AmiQual4Home Innovation Factory is a unique combination of three different innovation instruments:

1. Workshops for rapid prototyping of devices that embed perception, action, interaction and communication in ordinary objects based on the MIT FabLab model,
2. Facilities for real-world test and evaluation of devices and services organized as open Living Labs,
3. Resources for assisting students, researchers, entrepreneurs and industrial partners in creating new economic activities.

The AmiQual4Home Innovation Factory works with the Inovallee TARMAC technology incubator as well as the SAT Linksium to provide innovation and transfer services to enable students, researchers and local entrepreneurs to create and grow new commercial activities based on smart objects and services.

## 6. New Results

### 6.1. Simulating Haptic Sensations

Participants: Jingtao Chen, Sabine Coquillart, Partners: Inria GRA, LIG, GIPSA, G-SCOP

Pseudo-haptic feedback is a technique aiming to simulate haptic sensations without active haptic feedback devices. Pseudo-haptic techniques have been used to simulate various haptic feedbacks such as stiffness, torques, and mass. In the framework of the Persyval project, a novel pseudo-haptic experiment has been set up. The aim of this experiment is to study the force and EMG signals during a pseudo-haptic task. A stiffness discrimination task similar to the one published in Lecuyer's PhD thesis has been chosen. The experimental set-up has been developed, as well as the software controlling the experiment. Pre-tests have been conducted. They have been followed by formal tests with subjects.

### 6.2. Observing and Modeling Awareness and Expertise During Problem Solving

Participants: Thomas Guntz, Dominique Vaufreydaz, James Crowley, Philippe Dessus, Raffaella Balzarini

We have constructed an instrument for the capture and interpretation of multi-modal signals of humans engaged in solving challenging problems. Our instrument captures eye gaze, fixation, body posture and facial expressions and other physiological signals from humans engaged in interactive tasks on a touch screen.

As a pilot study, we have observed the eye gaze, fixation, body posture and facial expressions for 21 chess experts engaged in solving chess problems. We are currently exploring how such recordings can be used to estimate a subjects awareness of the current situation, and ability to respond effectively to challenging tasks.

### 6.3. Learning Routine Patterns of Activity in the Home

Participants: Julien Cumin, James Crowley Other Partners: Fano Ramparany, Greg Lefevre (Orange Labs)

During the month of February 2017, we have collected 4 weeks of data on daily activities within the Amiqua4Home Smart Home Living lab apartment. This dataset was presented at the international Conference on Ubiquitous Computing and Ambient Intelligence, UCAMI 2017, at Bethlehem PA, in Nov 2017 and is currently available for download from the Amiqua4Home web server (<http://amiqua4home.inria.fr/en/orange4home/>)

The objective of this research action is to develop a scalable approach to learning routine patterns of activity in a home using situation models. Information about user actions is used to construct situation models in which key elements are semantic time, place, social role, and actions. Activities are encoded as sequences of situations. Recurrent activities are detected as sequences of activities that occur at a specific time and place each day. Recurrent activities provide routines that can be used to predict future actions and anticipate needs and services. An early demonstration has been to construct an intelligent assistant that can respond to and filter inter-personal communications.

## 7. Bilateral Contracts and Grants with Industry

### 7.1. Bilateral Contracts with Industry

#### 7.1.1. Learning daily routines by observing activity in a smart home.

Members of the Pervasive interaction team are working with Orange Labs on techniques for observing activity and learning routines in a smart home. Activity is observed by monitoring use of electrical appliances and Communications media (Telephone, Television, Internet). Activities are described using Bayesian Situation Modeling techniques demonstrated in earlier projects. A log of daily activities is used to discover daily routines expressed as temporal sequences of contexts, where each context is expressed as a network of situations. Experiments will be performed using the Smart home living lab that has been constructed as part of the EquipEx Amiqua4home.

### **7.1.2. IRT Silver Economy**

Participants: James Crowley, Pierre Baret, Maxime Belgodere Partners: CEA, Schneider Electric.

Members of the Pervasive Interaction team are working with the CEA and Schneider Electric to develop environmental sensors that can detect when a hospital patient or elderly person has fallen and is unable to get up. The project uses an infrared Bolometric image sensor to observe human activity. Image processing and fall detection logic are to be performed by an embedded image processor on board.

## **8. Partnerships and Cooperations**

### **8.1. National Initiatives**

#### **8.1.1. ANR Project Involved**

Participants: Amr Alyafi, Patrick Reignier.

Other Partners: UMR G-SCOP, UMR LIG (Persuasive Interaction, IIHM, Getalp), CEA Liten, PACTE, Vesta Systems and Elithis.

Dates: Jan 2015 to Dec 2018

The ANR project Involved focuses on bringing solutions to building actors for upcoming challenges in energy management in residential buildings. The project explores a user centric energy management system, where user needs and tacit knowledge drive the search of solutions. These are calculated using a flexible energy model of the living areas. The system is personified by energy consultants with which building actors such as building owners, building managers, technical operators but also occupants, can interact with in order to co-define energy strategies, benefiting of both assets: tacit knowledge of human actors, and measurement with computation capabilities of calculators. Putting actors in the loop, i.e. making energy not only visible but also controllable is the needed step before large deployment of energy management solutions.

The project will develop interactive energy consultants for all the actors, providing energy management aided systems embedding models in order to support the decision making processes. MIRROR (interactive monitoring), WHAT-IF (interactive quantitative simulation), EXPLAIN (interactive qualitative simulation), SUGGEST- AND-ADJUST (interactive management) and RECOMMEND (interactive diagnosis) functionalities will be developed.

#### **8.1.2. ANR Project CEEGE: Chess Expertise from Eye Gaze and Emotion**

Participants: James Crowley, Dominique Vaufreydaz, Rafaellea Balzarini

Other Partners: Dept of NeuroCognition, CITEN, Bielefeld University

Dates: Jan 2016 to Dec 2019

CEEGE is a multidisciplinary scientific research project conducted by the Inria PRIMA team in cooperation with the Dept of Cognitive Neuroscience at the University of Bielefeld. The primary impacts will be improved scientific understanding in the disciplines of Computer Science and Cognitive Neuroscience. The aim of this project is to experimentally evaluate and compare current theories for mental modelling for problem solving and attention, as well as to refine and evaluate techniques for observing the physiological reactions of humans to situation that inspire pleasure, displeasure, arousal, dominance and fear.

In this project, we will observe the visual attention, physiological responses and mental states of subject with different levels of expertise solving classic chess problems, and participating in chess matches. We will observe chess players using eye-tracking, sustained and instantaneous face-expressions (micro-expressions), skin conductivity, blood flow (BVP), respiration, posture and other information extracted from audio-visual recordings and sensor readings of players. We will use the recorded information to estimate the mental constructs with which the players understand the game situation. Information from visual attention as well as physiological reactions will be used to determine and model the degree to which a player understands the game situation in terms of abstract configurations of chess pieces. This will provide a structured environment that we will use for experimental evaluation of current theories of mental modeling and emotional response during problem solving and social interaction.

The project is organized in three phases. During the first phase, we will observe individual players of different levels of chess expertise solving known chess problems. We will correlate scan-path from eye tracking and other information about visual attention to established configurations of pieces and known solutions to chess problems. This will allow us to construct a labeled corpus of chess play that can be used to evaluate competing techniques for estimating mental models and physiological responses. In a second phase, we will observe the attention and face expressions of pairs of players of different levels of chess ability during game play. In particular, we will seek to annotate and segment recordings with respect to the difficulty of the game situation as well as situations that elicit particularly strong physiological reactions. In the final phase, we will use these recordings to evaluate the effectiveness of competing techniques for mental modeling and observation of emotions in terms of their abilities to predict the chess abilities of players, game outcomes and individual moves and player self reports. Results of our work will be published in scientific conferences and journals concerned with cognitive science and cognitive neuroscience as well as computer vision, multimodal interaction, affective computing and pervasive computing. Possible applications include construction of systems that can monitor the cognitive abilities and emotional reactions of users of interactive systems to provide assistance that is appropriate but not excessive, companion systems that can aid with active healthy ageing, and tutoring systems that can assist users in developing skills in a variety of domains including chess.

### **8.1.3. CDP EcoSesa - Cross Disciplinary Project of the ComUE UGA**

Participants: James Crowley, Patrick Reignier, Rafallea Balzarini Dates: Jan 2017 to Dec 2020

Cities and their energy systems are undergoing profound transformations. Electric Power networks are being transformed from centralized, high capacity, generating plants, dimensioned to meet peak loads to decentralized, local, production based on intermittent renewable sources. This transformation is made possible by integration of information and energy technologies, new energy materials and components, and the rapid spread of pervasive computing. The result is a change in the socio-economics of energy distribution, and a change in the role of users from passive consumers to active participants in a dynamically fluctuating energy market. Many cities worldwide have initiated research projects and experiments to accelerate the spread of clean technologies. However, these initiatives generally focus on a specific issue that depends on the priorities and preferences of the local decision makers and stakeholders. At the same time, academic research has generally been confined to specialized silos in energy materials and management systems, in Social Sciences as well as in Information and Communication Technologies (ICT), resulting in piecemeal knowledge.

The vision of Eco-SESA is to address the problems resulting from the transition to clean decentralized energy production based on renewable sources with a holistic integrated humansystem approach. The project will address the development of Safe, Efficient, Sustainable and Accessible energy systems, from the individual end-user to dynamic communities of stakeholders at the district and grid levels.

Pervasive is involved in two research front of the project :

- Interactive systems to involve occupants of buildings
- Emerging behaviors from individual to communities

### **8.1.4. LabEx Persyval - Project MicroBayes: Probabilistic Machines for Low-level Sensor Interpretation**

Participants: Emmanuel Mazer, Raphael Frisch Other Partners: Laurent Girin (TIMA), Laurent Girin (GIPSA Lab), Didier Piau (L'Institut Fourier)

Dates: Nov 2016 to Nov 2019

The project MicroBayes builds on results of the recently completed EC FET Open project BAMBI to explore a new technique for Blind source separation and acoustic signal location using a new form of Bayesian Computer. The techniques have recently been demonstrated using a software simulation. Current plans are to implement and demonstrate the Bayesian computer using an FPGA. By the end of the project we expect to produce a hardware implementation suitable for use in low-cost low-power applications.

### **8.1.5. Competitvity Clusters**

James Crowley is on the scientific committee for the Minalogic Competitvity Cluster. Minalogic is the global innovation cluster for digital technologies serving France's Auvergne-Rhône-Alpes region. The Scientific Committee advises the pole of strategy, advises local industry in proposal preparation, reviews FUI project proposals, and makes recommendations about labelling and support of project proposals.

## **9. Dissemination**

### **9.1. Promoting Scientific Activities**

#### **9.1.1. Scientific Events Organisation**

##### *9.1.1.1. General Chair, Scientific Chair*

- Sabine Coquillart General co-chair, "Nouveaux Défis de l'Internet des Objets 2017 - Technique, Usage, Ethique", Fès-ESISA (Maroc), 17-18 mai 2017.

##### *9.1.1.2. Member of the Organizing Committees*

- Dominique Vaufreydaz organised the workshop "Behavior, Emotion and Representation: Building Blocks of Interaction" (BER 2017) at the 5th International Conference on Human-Agent Interaction (HAI 2017), Bielefeld Germany, Oct 2017.
- Patrick Reignier is a member of the organizing committee for the workshop "Context in the Home", at conference Context 17 in Paris in June 2017.

#### **9.1.2. Scientific Events Selection**

##### *9.1.2.1. Chair of Conference Program Committees*

- James Crowley served as chairman of the awards committee for the 2017 International Conference on Multimodal Interaction.

##### *9.1.2.2. Member of Conference Program Committees*

Patrick Reignier was a member of the program committee

- SmartObject 2017

Thierry Fraichard was a member of the international program committee

- the European Conference on Mobile Robots (ECMR 2017)

Sabine Coquillart has served as a member of the program committee for the following conferences.

- GRAPP 2017 - The 12nd International Conference on Computer Graphics Theory and Applications, Porto, Portugal, February 2017
- IEEE VR - IEEE Virtual Reality 2017, Los Angeles, USA, March 2017
- IEEE 3DUI - IEEE 3D User Interfaces 2017, Los Angeles, USA, March 2017
- WSCG 2017 - International Conferences in Central Europe on Computer Graphics, Visualization and Computer Vision, Plzen, Czech Republic, May 2017
- CENTRIC 2017 - The Tenth International Conference on Advances in Human-oriented and Personalized Mechanisms, Technologies, and Services, Athens, Greece, October 2017
- ICAT-EGVE 2017 - International Conference on Artificial Reality and Telexistence and Eurographics Symposium on Virtual Environments, Adelaide, Australia, November 2017
- VRST 2017 - 23rd ACM Symposium on Virtual Reality Software and Technology, Gothenburg, Sweden, November 2017

#### 9.1.2.3. Reviewer

- James Crowley reviewed papers for ICCV 2017 - International conference on Computer Vision.
- James Crowley reviewed papers for CVPR 2017 - International conference on Computer Vision and Pattern Recognition.
- James Crowley reviewed papers for ICVS 2017 - International conference on Vision Systems.
- Dominique Vaufreydaz was in Program committee members and reviewed articles for seventh International Conference on Affective Computing and Intelligent Interaction (ACII2017), which will be held in San Antonio, Texas on October 23-26, 2017.
- Dominique Vaufreydaz reviewed articles for the Interactive Technology and Smart Education, 2017.
- Dominique Vaufreydaz reviewed articles for the 13th Annual ACM/IEEE International Conference on Human Robot Interaction (HRI)Chicago, IL, USA, March 5–8, 2018.

### 9.1.3. Journal

#### 9.1.3.1. Member of the Editorial Boards

- Patrick Reignier is a member of the editorial board of the Modeling and Using Context Journal (ISTE OpenScience)
- Sabine Coquillart is a member of the Scientific Committee of the Journal of Virtual Reality and Broadcasting.
- Sabine Coquillart is a member of the Advisory/Editorial Board for the International Journal of Computer Graphics – SERSC.
- Sabine Coquillart is a Member of the Academic Editors Board of “PeerJ Computer Science” – open access Journal in Computer Science.
- Sabine Coquillart is Review Editor for the “Frontiers in Virtual Environments” journal.
- Thierry Fraichard is serving as an Associate Editor for IEEE Robotics and Automation Letters. He also served as an Associate Editor for IEEE/RSJ Int. Conf. on Robots and Systems (IROS).
- Thierry Fraichard is an Associate Editor for IEEE Robotics and Automation Letters (RA-L).

#### 9.1.3.2. Reviewer - Reviewing Activities

- Thierry Fraichard reviewed articles for the Int. Journal of Aerospace Engineering, IEEE Trans. Intelligent Vehicles, and IEEE Trans. on Industrial Electronics.
- Thierry Fraichard reviewed articles for IEEE Trans. on Robotics (TRO) and IEEE Robotics and Automation Letters (RA-L).
- Patrick Reignier served as a reviewer for the 2 educational call for projects of the University Grenoble Alps Idex

#### **9.1.4. Invited Talks**

James Crowley gave the following invited talks in 2017

- "Câblé, connecté ou écologique : trois visions pour l'habitat de demain " Journées de l'habitat intelligent et innovation dans le logement social, Absise - Les Bailleurs Sociaux de l'Isere, Grenoble, 23 May 2017.
- "Interaction avec le monde, avec autrui et soi-même : trois facettes de l'intelligence", Ideas Day, Ideas Laboratory, Grenoble, 4 Jul 2017.

Sabine Coquillart gave the following invited talk

- "Pseudo-Haptique : Etat de l' Art et Challenges", LIMSI, December 1st, 2017

Thierry Fraichard gave an invited talk

- "Formal methods will not prevent self-driving cars from having accidents" at the Forum Méthodes Formelles in Toulouse (FR), October 2017.

Dominique Vaufreydaz gave the following invited talk in 2017

- "Pedestrian detection and behaviors modelling in Urban environment" at "Smart Mobility and Intelligent Vehicles" (SMIV2017), Vedecom Institute, 8/9 November 2017.

#### **9.1.5. Leadership within the Scientific Community**

- James Crowley is a member of the Steering Committee for the ACM International Conference on Multimodal Interaction.
- Sabine Coquillart is serving as member of the steering committee for the ICAT conference – International Conference on Artificial Reality and Telexistence.
- Sabine Coquillart is chairing the steering committee for the EGVE Working Group – EUROGRAPHICS Working group on Virtual Environments.
- Sabine Coquillart is elected member of the EUROGRAPHICS Executive Committee.
- Sabine Coquillart is member of the EUROGRAPHICS Working Group and Workshop board.

#### **9.1.6. Scientific Expertise**

- James L. Crowley served on the selection committee for the Institut Université de France (IUF)
- James L. Crowley served as Vice chairman for the selection panel for H2020 FET Open.
- James L. Crowley served on the selection panel for the H2020 ICT Robotics program
- James L. Crowley served on the ANR committee CE 33 Interaction, Robotics.
- Sabine Coquillart served as an expert reviewer for the Austrian Science Fund (FWF).
- Dominique Vaufreydaz served as evaluator pour l' ANR
- Thierry Fraichard served as an expert reviewer for the European Commission
- Patrick Reignier is a member of the Scientific Council of the Amiqua4Home Equipex

#### **9.1.7. Research Administration**

- James Crowley is director for the Amiqua4Home Innovation Platform (EquipEx).
- James Crowley serves on the Administrative Committee (Bureau) for the Laboratoire Informatique de Grenoble.
- James Crowley served on the Scientific Committee (CoS) for the CRI Inria Grenoble-Rhone Alpes.
- James Crowley served on the orientation committee for the Competitvety Pole Minalogic
- Patrick Reignier is head of the engineering support group of the Laboratoire d'Informatique de Grenoble (13 members). He is currently supervising the moving of the Domus Living lab to a new site on Campus.

- Patrick Reignier serves on the Administrative Office (Bureau) for the Laboratoire Informatique de Grenoble.
- Patrick Reignier is a member of the comité de pilotage of the Domus Living Lab
- Patrick Reignier is a member of the Comité Executif of the Amiqua4Home Equipex

## 9.2. Teaching - Supervision - Juries

### 9.2.1. Teaching

#### 9.2.1.1. James Crowley

James Crowley is co-director of the Master of Science in Informatics at Grenoble (MoSIG).

Master : Computer Vision, Course 27h EqTD, M2 year, Master of Science in Informatics at Grenoble

Master 1: Intelligent Systems, Cours 54h EqTD, ENSIMAG and UFRIM2AG

ENSIMAG 3 : Pattern Recognition and Machine Learning, Cours 27h EqTD, ENSIMAG

#### 9.2.1.2. Patrick Reignier

- Patrick Reignier has been elected member of the Conseil des Etudes et de la Vie Universitaire of Grenoble INP
- Patrick Reignier has been nominated as a member of the Conseil de la Formation Continue de Grenoble INP
- Patrick Reignier participated in the editing of an successful Idex Educational program proposal "FromLivingLab".
- Patrick Reignier is co-director of the "formation en apprentissage" of Ensimag (3 years program : 1 year for the Licence and 2 years for the Master)
- Patrick Reignier Supervises the industrial part of the "formation en apprentissage" of the Ensimag engineering school.
- Master: Patrick Reignier, Projet Genie Logiciel, 55h eqTD, M1, Ensimag/Grenoble INP, France.
- Master: Patrick Reignier, Développement d'applications communicantes, 18h eqTD, M2, Ensimag/Grenoble-INP, France
- Master: Patrick Reignier, Introduction aux applications reparties, 18h eqTD, M2, Ensimag/Grenoble-INP, France
- Master: Patrick Reignier, Applications Web et Mobiles , 27h eqTD, M1, Ensimag/Grenoble-INP, France
- Master: Patrick Reignier, Projet Systeme, 12h eq TD, M1, Ensimag/Grenoble-INP, France
- Licence: Patrick Reignier, Projet C, 20h eqTD, L3, Ensimag/Grenoble-INP, France.

#### 9.2.1.3. Dominique Vaufreydaz

- Co-responsibility of the Graphic, Vision and Robotics track of the MOSIG Master program.
- In charge of the transversal numerical competence courses at the Grenoble Faculty of Economics (Grenoble and Valence campuses)
- Licence: Compétences Numériques, 126h eq TD,L1, Université Grenoble Alpes, France.
- Licence: Informatique appliquée à l'économie et à la gestion, 32 h eq TD, enseignement à distance, Licence, Université Grenoble Alpes, France.
- Licence: Pratique avancée du Tableur, 72 h eq TD, L3, Université Grenoble Alpes, France.
- Licence Professionnelle: Enquêtes et traitement d'enquêtes avec le logiciel Sphinx, 12h eq TD, Licence pro Métiers de l'Emploi et de la Formation, Université Grenoble Alpes, France.
- Licence Professionnelle: Administration en environnement hétérogène, 20h eq TD, Licence pro Administration et Sécurité des Systèmes et des Réseaux, Université Grenoble Alpes, France.



- IUT année spéciale: Programmation C++, 18h eq TD, Année Spéciale IUT Informatique, Université Grenoble Alpes, France.
- Master: Pratique avancée du Tableur, 24 h eq TD, M1 économie internationale et stratégies d'acteurs, Université Grenoble Alpes, France.
- Master: Traitement des données du Web, 15h eq TD, M2 Mathématiques et Informatique Appliquées aux Sciences Humaines et Sociales, Université Grenoble Alpes, France
- Master: Développement Web Mobile, 15h eq TD, M2 Mathématiques et Informatique Appliquées aux Sciences Humaines et Sociales, Université Grenoble Alpes, France

#### 9.2.1.4. *Thierry Fraichard*

- Master: Thierry Fraichard, Autonomous Robotics, 22.5h eqTD, M2 MOSIG, Univ Grenoble Alpes.

### 9.2.2. *Supervision - Doctoral theses completed in 2017*

- PhD : Marvin Faix, Conception d'un ordinateur probabiliste, Univ Grenoble Alpes, Janvier 2017, Emmanuel Mazer and Laurent Fesquet
- PhD Jingtao Chen, "Biomechanical Analysis of Different Aspects in Virtual Reality. Application", PhD UGA, January 30th, 2017, Peter Mitrouchev, Franck Quaine and Sabine Coquillart
- PhD : Gregoire Nieto, Light Field Remote Vision, Univ Grenoble Alpes, 3 Oct 2017, Frederic Devernay and James Crowley
- PhD : Ta Viet Cuong, Smartphone-based indoor positioning using Wi-Fi, Inertial sensors and Bluetooth, Univ Grenoble Alpes, 15 Dec 2017, Dominique Vaufreydaz and Eric Castelli

### 9.2.3. *Supervision - Current Doctoral Students*

- PhD in progress : Romain Bregier, Détection et estimation de pose d'instances d'objet rigide pour la manipulation robotisée, Octobre 2014, Frederic Devernay and James Crowley
- PhD in progress : Rémi Paulin, socially aware navigation, Octobre 2014, Patrick Reignier and Thierry Fraichard.
- PhD in progress : Etienne Balit, expressive social robot design, Octobre 2014, Patrick Reignier and Dominique Vaufreydaz.
- PhD in progress : Interaction-Aware Tracking and Lane Change Detection in Highway Driving, David Sierra Gonzales, Octobre 2014, Dizan Vasquez and Emmanuel Mazer
- PhD in progress : Minh-khoa Nguyen, Robotics-inspired methods for modeling and simulation of large nanosystems, Octobre 2014, Leonard Jaillet and Emmanuel Mazer
- PhD in progress : Amr Alyafi, explanatory observation of energy usage, Octobre 2015, Stephane Ploix and Patrick Reignier.
- PhD in progress : Amine Awada, activity recognition for smart energy management, Octobre 2015, Stephane Ploix and Patrick Reignier.
- PhD in progress : Liliya Tsetanova, Social Robotics, Octobre 2015, Veronique Aubergé and Patrick Reignier.
- PhD in progress : Julien Cumin, Learning Patterns of Activities for Context Aware Services, Octobre 2015, James Crowley and Fano Ramparany
- PhD in progress : Sandra Nabil, Synthesis of Panoramic Videos, Octobre 2015, Frederic Devernay and James Crowley
- PhD in progress : Jose Grimaldo Da Silva Filho, "Human-Robot Motion, a Shared Effort Approach", Octobre 2015, Thierry Fraichard.
- PhD in progress : Thomas Guntz, Multimodal Observation of Subjects Engaged in Problem Solving, Octobre 2016, James Crowley and Dominique Vaufreydaz

- PhD in progress : Nashwa Abubakr, Observation of Kitchen Activities, Octobre 2016, James Crowley and Remi Ronfard
- PhD in progress : Raphael Frisch, conception de machine stochastique pour la localisation et la séparation de source sonor, Octobre 2016, Emmanuel Mazer
- PhD in progress: Matteo Ciocca, "Safe Robot Motion", Octobre 2016, Thierry Fraichard and Pierre-Brice Wieber.

#### 9.2.4. Juries

- James Crowley served as President of the Doctoral Jury for Tiana Rakotovao Andriamahefa, University Grenoble Alps, March 2017
- Patrick Reignier served as a jury member of the Doctoral Jury of Nadine Mandran (University Grenoble Alps)
- Patrick Reignier served as a president of the Doctoral Jury of Sarah Bouzit (University Grenoble Alps)
- Patrick Reignier served as a president of the Doctoral Jury of Manar Amayri (University Grenoble Alps)
- Patrick Reignier served as a president of the Doctoral Jury of Antoine Foulonneau (University Grenoble Alps)
- Sabine Coquillart served as reporter for the doctoral jury of B. Le Gouis at INSA Rennes
- Sabine Coquillart served as examiner for the doctoral jury of P. Isartel at LIMSI, Univ. Paris-Orsay.
- Thierry Fraichard served as an expert evaluator in the PhD Jury of Suhyeon Gim, Univ. of Toulouse (FR), May 2017.
- Thierry Fraichard served as an expert evaluator in the PhD Jury of Alexandre Boeuf, Univ. of Clermont-Ferrand (FR), July 2017.

## 10. Bibliography

### Publications of the year

#### Articles in International Peer-Reviewed Journals

- [1] R. BRÉGIER, F. DEVERNAY, L. LEYRIT, J. CROWLEY. *Defining the Pose of any 3D Rigid Object and an Associated Distance*, in "International Journal of Computer Vision", November 2017, pp. 1-25, <https://arxiv.org/abs/1612.04631> [DOI : 10.1007/s11263-017-1052-4], <https://hal.inria.fr/hal-01415027>
- [2] J. CHEN, P. MITROUCHEV, S. COQUILLART, Q. FRANCK. *Disassembly task evaluation by muscle fatigue estimation in a virtual reality environment*, in "International Journal of Advanced Manufacturing Technology", February 2017, vol. 88, n<sup>o</sup> 5-8, pp. 1523 - 1533 [DOI : 10.1007/s00170-016-8827-6], <https://hal.archives-ouvertes.fr/hal-01676643>
- [3] S. CROUZY, S. BORKOWSKI, S. COQUILLART. *Ambient Atoms: a Device for Ambient Information Visualization*, in "Open Science - Internet des objets", June 2017, vol. 17, n<sup>o</sup> 2 [DOI : 10.21494/ISTE.OP.2017.0152], <https://hal.archives-ouvertes.fr/hal-01676636>
- [4] J. TORRES-SOSPEDRA, A. JIMÉNEZ, S. KNAUTH, A. MOREIRA, Y. K. BEER, T. FETZER, V.-C. TA, R. M. MONTOLIU, F. SECO, G. M. MENDOZA-SILVA, O. BELMONTE, A. KOUKOFIKIS, M. J. NICOLAU, A. COSTA, F. M. MENESES, F. EBNER, F. DEINZER, D. VAUFREYDAZ, T.-K. DAO, E. CASTELLI. *The Smartphone-Based Offline Indoor Location Competition at IPIN 2016: Analysis and Future Work*, in "Sensors", 2017, vol. 557, 17 p. [DOI : 10.3390/s17030557], <https://hal.inria.fr/hal-01490744>

### International Conferences with Proceedings

- [5] A. ALZOUHRI ALYAFI, J.-P. GUILLBAUD, P. REIGNIER, S. PLOIX. *Explanations Engine For Energy Management Systems in Buildings*, in "The 9th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications", Bucharest, Romania, IEEEExplore, September 2017, <https://hal.archives-ouvertes.fr/hal-01576248>
- [6] A. ALZOUHRI ALYAFI, M. PAL, S. PLOIX, P. REIGNIER, S. BANDYOPADHYAY. *Differential Explanations for Energy Management in Buildings*, in "Computing Conference 2017", Londres, United Kingdom, IEEEExplore, IEEE, July 2017, <https://hal.archives-ouvertes.fr/hal-01576282>
- [7] A. BARBULESCU, A. BEGAULT, L. BOISSIEUX, M.-P. CANI, M. GARCIA, M. PORTAZ, A. VIAND, P. HEINISH, R. DULERY, R. RONFARD, D. VAUFREYDAZ. *Making Movies from Make-Believe Games*, in "6th Workshop on Intelligent Cinematography and Editing (WICED 2017)", Lyon, France, April 2017, <https://hal.inria.fr/hal-01518981>
- [8] A. BARBULESCU, M. GARCIA, A. BEGAULT, L. BOISSIEUX, M.-P. CANI, M. PORTAZ, A. VIAND, R. DULERY, P. HEINISH, R. RONFARD, D. VAUFREYDAZ. *A system for creating virtual reality content from make-believe games*, in "IEEE Virtual Reality 2017", Los Angeles, United States, IEEE, March 2017, pp. 207-208 [DOI : 10.1109/VR.2017.7892249], <https://hal.inria.fr/hal-01578326>
- [9] M. BOBIN, H. AMROUN, S. COQUILLART, F. BIMBARD, M. AMMI. *DNN based Approach for the Assessment of Elbow Flexion with Smart Textile Sensor*, in "SMC 2017 - IEEE International Conference on Systems, Man, and Cybernetics", Banff, Canada, October 2017, <https://hal.archives-ouvertes.fr/hal-01677679>
- [10] M. CIOCCA, P.-B. WIEBER, T. FRAICHARD. *Strong Recursive Feasibility in Model Predictive Control of Biped Walking*, in "HUMANOIDS 2017 - IEEE-RAS International Conference on Humanoid Robots", Birmingham, United Kingdom, November 2017, <https://hal.inria.fr/hal-01618881>
- [11] J. L. COUTAZ, J. L. CROWLEY. *Evaluation of Programmable Domestic Eco-systems: "Living in it" as an Experimental Method*, in "29ème conférence francophone sur l'Interaction Homme-Machine", Poitiers, France, AFIHM (editor), ACM, August 2017, 12 p. [DOI : 10.1145/3132129.3132138], <https://hal.archives-ouvertes.fr/hal-01578502>
- [12] S. CROUZY, S. BORKOWSKI, S. COQUILLART. *Ambient Atoms : un périphérique pour la visualisation ambiante d'informations*, in "Nouveaux Défis de l'Internet des Objets 2017 - Technique, Usage, Ethique", Fes, Morocco, May 2017, <https://hal.archives-ouvertes.fr/hal-01676648>
- [13] J. CUMIN, G. LEFEBVRE, F. RAMPARANY, J. L. CROWLEY. *A Dataset of Routine Daily Activities in an Instrumented Home*, in "UCAmI 2017 - 11th International Conference on Ubiquitous Computing and Ambient Intelligence", Philadelphie, United States, S. OCHOA, P. SINGH, J. BRAVO (editors), Ubiquitous Computing and Ambient Intelligence, Springer, November 2017, vol. 10586, pp. 413-425 [DOI : 10.1007/978-3-319-67585-5\_43], <https://hal.archives-ouvertes.fr/hal-01639673>
- [14] J. CUMIN, G. LEFEBVRE, F. RAMPARANY, J. L. CROWLEY. *Human Activity Recognition Using Place-Based Decision Fusion in Smart Homes*, in "10th International and Interdisciplinary Conference, CONTEXT 2017", Paris, France, P. BRÉZILLON, R. TURNER, C. PENCO (editors), Modeling and Using Context, Springer Verlag, June 2017, vol. 10257, pp. 137 - 150 [DOI : 10.1145/1865987.1866010], <https://hal.inria.fr/hal-01555334>

- [15] J. G. DA SILVA FILHO, T. FRAICHARD. *Human Robot Motion: A Shared Effort Approach*, in "European Conference on Mobile Robotics", Paris, France, September 2017, <https://hal.inria.fr/hal-01565873>
- [16] T. GUNTZ, R. BALZARINI, D. VAUFREYDAZ, J. L. CROWLEY. *Multimodal Observation and Interpretation of Subjects Engaged in Problem Solving*, in "1st Workshop on "Behavior, Emotion and Representation: Building Blocks of Interaction"", Bielefeld, Germany, October 2017, <https://arxiv.org/abs/1710.04486> , <https://hal.inria.fr/hal-01615461>
- [17] P. LAGO, F. LANG, C. RONCANCIO, C. JIMÉNEZ-GUARÍN, R. MATEESCU, N. BONNEFOND. *The ContextAct@A4H real-life dataset of daily-living activities Activity recognition using model checking*, in "10th International and Interdisciplinary Conference - CONTEXT 2017", Paris, France, P. BRÉZILLON, R. TURNER, C. PENCO (editors), Lecture Notes in Computer Science, Springer Verlag, June 2017, vol. 10257, pp. 175-188 [DOI : 10.1007/978-3-319-57837-8\_14], <https://hal.archives-ouvertes.fr/hal-01551418>
- [18] P. MITROUCHEV, J. CHEN, S. COQUILLART, F. QUAINÉ. *Disassembly task evaluation in virtual reality environment.*, in "MIT Conference and Workshop 2017 - Management and Innovative Technologies", Sinaia, Romania, September 2017, vol. 88, n<sup>o</sup> 5-8, pp. 1523-1533 [DOI : 10.1007/s00170-016-8827-6], <https://hal.archives-ouvertes.fr/hal-01660732>
- [19] G. NIETO, F. DEVERNAY, J. CROWLEY. *Linearizing the Plenoptic Space*, in "Light Fields for Computer Vision", Honolulu, United States, The IEEE Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, July 2017, <https://hal.inria.fr/hal-01572479>
- [20] M. PAL, R. SENGUPTA, S. BANDYOPADHYAY, A. A. ALYAFI, S. PLOIX, P. REIGNIER, S. SAHA. *Analysis of Optimizers to Regulate Occupant's Actions for Building Energy Management*, in "ICAPR 2017 - Ninth International Conference on Advances in Pattern Recognition", Bangalore, India, IEEEEXPlore, IEEE, December 2017, <https://hal.archives-ouvertes.fr/hal-01675162>
- [21] M. PORTAZ, M. GARCIA, A. BARBULESCU, A. BEGAULT, L. BOISSIEUX, M.-P. CANI, R. RONFARD, D. VAUFREYDAZ. *Figurines, a multimodal framework for tangible storytelling*, in "WOCCI 2017 - 6th Workshop on Child Computer Interaction at ICMI 2017 - 19th ACM International Conference on Multi-modal Interaction", Glasgow, United Kingdom, November 2017, Author version, <https://hal.inria.fr/hal-01595775>
- [22] P. VASISHTA, D. VAUFREYDAZ, A. SPALANZANI. *Natural Vision Based Method for Predicting Pedestrian Behaviour in Urban Environments*, in "IEEE 20th International Conference on Intelligent Transportation Systems", Yokohama, Japan, October 2017, <https://hal.inria.fr/hal-01561029>

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- [23] P. VASISHTA, D. VAUFREYDAZ, A. SPALANZANI. *Urban Pedestrian Behaviour Modelling using Natural Vision and Potential Fields*, in "9th Workshop on Planning, Perception and Navigation for Intelligent Vehicles at the IEEE International Conference on Intelligent Robots and Systems", Vancouver, Canada, September 2017, <https://hal.inria.fr/hal-01578741>

### Scientific Popularization

- [24] T. FRAICHARD. *Will the driver Seat Ever be Empty?*, in "ERCIM News", April 2017, n<sup>o</sup> 109, pp. 39-40, <https://hal.inria.fr/hal-01499572>