IN PARTNERSHIP WITH:
CNRS

Institut polytechnique de Grenoble

Université de Grenoble Alpes

Activity Report 2019

Project-Team PERVASIVE

Pervasive interaction with smart objects and environments

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

RESEARCH CENTER
Grenoble - Rhône-Alpes

THEME
Robotics and Smart environments

Table of contents

Project-Team PERVASIVE

Creation of the Project-Team: 2017 November 01

Keywords:

Computer Science and Digital Science:

A1.4. - Ubiquitous Systems
A1.6. - Green Computing
A3.4.5. - Bayesian methods
A3.4.6. - Neural networks
A3.4.8. - Deep learning
A3.5.2. - Recommendation systems
A5.1.7. - Multimodal interfaces
A5.1.9. - User and perceptual studies
A5.4. - Computer vision
A5.6. - Virtual reality, augmented reality
A5.7. - Audio modeling and processing
A5.10.2. - Perception
A5.10.3. - Planning
A5.10.4. - Robot control
A5.10.5. - Robot interaction (with the environment, humans, other robots)
A5.11. - Smart spaces
A9. - Artificial intelligence

Other Research Topics and Application Domains:

B1.2.2. - Cognitive science
B2.1. - Well being
B2.5.3. - Assistance for elderly
B6.4. - Internet of things
B6.6. - Embedded systems
B8.1. - Smart building/home
B8.1.1. - Energy for smart buildings
B8.1.2. - Sensor networks for smart buildings
B9.1.1. - E-learning, MOOC

1. Team, Visitors, External Collaborators

Research Scientists

Eric Castelli [CNRS, Researcher, HDR]
Sabine Coquillart [Inria, Senior Researcher, HDR]
Thierry Fraichard [Inria, Researcher, HDR]
Emmanuel Mazer [CNRS, Senior Researcher, until Oct 2019, HDR]

Faculty Members

James Crowley [Team leader, Institut polytechnique de Grenoble, Professor, HDR]
Philippe Dessus [Univ Grenoble Alpes, Professor, until Aug 2019, HDR]

Patrick Reignier [Institut polytechnique de Grenoble, Professor, HDR]
Dominique Vaufreydaz [Univ Grenoble Alpes, Associate Professor, HDR]

Post-Doctoral Fellows
Amr Al-Zouhri Al-Yafi [Univ Grenoble Alpes, Post-Doctoral Fellow, from Jun 2019]
Marvin Faix [Univ Grenoble Alpes, Post-Doctoral Fellow, until Oct 2019]
Ivana Schenk [Inria, Post-Doctoral Fellow, until Oct 2019]

PhD Students
Nachwa Abou Bakr [Univ Grenoble Alpes, PhD Student]
Louis Airale [Univ Grenoble Alpes, PhD Student, from Oct 2019]
Matteo Ciocca [Univ Grenoble Alpes, PhD Student]
Jose Da Silva Filho [Inria, PhD Student]
Amr Al-Zouhri Al-Yafi [Univ Grenoble Alpes, PhD Student]
Raphael Lambert Frisch [Univ Grenoble Alpes, PhD Student, until Oct 2019]
Thomas Guntz [Inria, PhD Student]
Romain Laurent [Univ Grenoble Alpes, PhD Student, from Feb 2019]
Rottana Ly [Ministre des Affaires Etrangeres, PhD Student, from Nov 2019]

Technical staff
Raffaella Balzarini [Inria, Engineer]
Maxime Belgodere [Inria, Engineer, until Sep 2019]
Eric Boucher [Inria, Engineer, from Mar 2019]
Anthony Chavoutier [Inria, Engineer, until Jun 2019]
Benjamin Girard [Inria, Engineer]
Samuel Heidmann [Inria, Engineer, until Aug 2019]

Interns and Apprentices
Julien Alaimo [Inria, from May 2019 until Aug 2019]
Peter Bardawil [Univ Grenoble Alpes, from Jul 2019 until Sep 2019]
John Chmilar [Univ Grenoble Alpes, from May 2019 until Jul 2019]
Thomas Debeuret [Inria, from Feb 2019 until Jun 2019]
Mathias Deplanque [Univ Grenoble Alpes, from Apr 2019 until Jul 2019]
Thanh Ho Sy [Inria, from Feb 2019 until Jul 2019]
Valentin Levesy [Univ Grenoble Alpes, from Feb 2019 until Jun 2019]
Kajal Puri [Inria, from Jul 2019 until Aug 2019]
Juan Fernando Vazquez Rodriguez [Inria, from Jun 2019 until Sep 2019]
Jing Xiao [Univ Grenoble Alpes, from Feb 2019 until Jul 2019]
Haiyin Xu [Inria, from Feb 2019 until Jun 2019]

Administrative Assistants
Alexandra Fitzgerald [Inria, Administrative Assistant, until Sep 2019]
Julia Di Toro [Inria, Administrative Assistant, from Oct 2019]

External Collaborators
Jeremy Belot [Univ Grenoble Alpes, until Aug 2019]
Joelle Coutaz [Univ Grenoble Alpes]
Philippe Dessus [Univ Grenoble Alpes, from Sep 2019, HDR]
Didier Piau [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. Modelling Human Awareness and Undestanding

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 has addressed 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.

The challenges in this research area have been 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 Julien 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 mobiles 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. 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 concerns 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 have developed 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 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 modelling 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 have explored 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 explored 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].

We have adapted this work to construct narrative descriptions of cooking activities from ego-centric vision, 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. Observing and Modelling Competence and Awareness from Eye-gaze and Emotion

Humans display awareness and emotions through a variety of non-verbal channels. It is increasingly possible to record and interpret such information with available technology. Publicly available software can be used to efficiently detect and track face orientation using web cameras. Concentration can be inferred from changes in pupil size [Kahneman 66]. Observation of Facial Action Units [Ekman 71] can be used to detect both sustained and instantaneous (micro-expressions) displays of valence and excitation. Heart rate can be measured from the Blood Volume Pulse as observed from facial skin color [Poh 11]. Body posture and gesture can be obtained from low-cost RGB sensors with depth information (RGB+D) [Shotton 13] or directly from images using detectors learned using deep learning [Ramakrishna 14]. Awareness and attention can be inferred from eye-gaze (scan path) and fixation using eye-tracking glasses as well as remote eye tracking devices [Holmqvist 11]. Such recordings can be used to reveal awareness of the current situation and to predict ability to respond effectively to opportunities and threats.

This work is supported by the ANR project CEEGE in cooperation with the department of NeuroCognition of Univ. Bielefeld. Work in this area includes the Doctoral research of Thomas Guntz to be defended in 2019.

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, pp. 1-17, 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.

[Coutaz 05] J. Coutaz, J.L. Crowley, S. Dobson, D. Garlan, "Context is key", Communications of the ACM, 48 (3), pp. 49-53, 2005.

[Crowley 15] J. L. Crowley and J. Coutaz, "An Ecological View of Smart Home Technologies", 2015 European Conference on Ambient Intelligence, Athens, Greece, Nov. 2015.

[Gandhi 13] Vineet Gandhi, Remi Ronfard. "Detecting and Naming Actors in Movies using Generative Appearance Models", Computer Vision and Pattern Recognition, 2013.

[Gandhi 14] Vineet Gandhi, Rémi Ronfard, Michael Gleicher. "Multi-Clip Video Editing from a Single Viewpoint", European Conference on Visual Media Production, 2014

[Ronfard 14] R. Ronfard, N. Szilas. "Where story and media meet: computer generation of narrative discourse". Computational Models of Narrative, 2014.

[Galvane 15] Quentin Galvane, Rémi Ronfard, Christophe Lino, Marc Christie. "Continuity Editing for 3D Animation". AAAI Conference on Artificial Intelligence, Jan 2015.

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

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

[Kahneman 66] D. Kahneman and J. Beatty, Pupil diameter and load on memory. Science, 154(3756), pp. 1583-1585, 1966.

[Ekman 71] P. Ekman and W.V. Friesen, Constants across cultures in the face and emotion. Journal of Personality and Social Psychology, 17(2), 124, 1971.

[Poh 11] M. Z. Poh, D. J. McDuff, and R. W. Picard, Advancements in noncontact, multiparameter physiological measurements using a webcam. IEEE Trans. Biomed. Eng., 58, pp. 7–11, 2011.

[Shotton 13] J. Shotton, T. Sharp, A. Kipman, A. Fitzgibbon, M. Finocchio, A. Blake, M. Cook, and R. Moore, Real-time human pose recognition in parts from single depth images. Commun. ACM, 56, pp. 116–124, 2013.

[Ramakrishna 14] V. Ramakrishna, D. Munoz, M. Hebert, J. A. Bagnell and Y. Sheikh, Pose machines: Articulated pose estimation via inference machines. In European Conference on Computer Vision (ECCV 2016), pp. 33-47, Springer, 2014.

[Cao 17] Z. Cao, T. Simon, S. E. Wei and Y. Sheikh, Realtime Multi-person 2D Pose Estimation Using Part Affinity Fields. In 2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2017), IEEE Press, pp. 1302-1310, July, 2017.

[Holmqvist 11] K. Holmqvist, M. Nyström, R. Andersson, R. Dewhurst, H. Jarodzka, and J. van de Weijer, Eye Tracking: A Comprehensive Guide to Methods and Measures, OUP Oxford: Oxford, UK, 2011.

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.

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. 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.

3.4.2. 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.

3.4.3. 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), 1-20, 2010

4. Application Domains

4.1. Modelling of awareness and expertise from Eye Gaze and Emotion

Humans display awareness and expertise through a variety of non-verbal channels. It is increasingly possible to record and interpret such information with available technology. In the ANR CEEGE project, have constructed an instrument for capturing and interpreting multimodal signals of humans engaged in solving challenging problems. Our instrument captures eye gaze, fixations, body postures, and facial expressions signals from humans engaged in interactive tasks on a touch screen.

An initial experiment with multi-modal observation of human experts engaged in solving problems in Chess revealed an unexpected observation of rapid changes in emotion as players attempt to solve challenging problems. In a scientific collaboration with the NeuroCognition group at the Univ Bielefeld, we have constructed to explain for chess experts that explains these unexpected results. This model has recently been tested in a second experiment with 22 chess players. Our results indicate that chess players associate emotions to chess chunks, and reactively use these associations to guide search in chunks for planning and problem solving. These results have recently been reported in a paper at the International Conference on Multimodal Interaction, and is the subject of the nearly completed doctoral dissertation of Thomas Guntz.

The results are currently being used in the construction of a student aware driver training device to be commercialized by SME company Sym2B financed by the SATT Linksium Project MAT: Monitoring Attention of Trainees, starting in Sept 2019. IN this project we will construct a training simulator for operation of busses and tramways.

4.2. Narrative Description of Kitchen Activities from Egocentric Video

We have developed and evaluated a system to construct situated, narrative descriptions of cooking activities including food preparation, place setting, cleaning and placing objects in storage areas. We are specifically interested in real-time, on-line techniques that recognize and interpret food types, food states and manipulation actions for transformation preparation of food. We are exploring techniques for detecting, modelling, and recognising a large vocabulary of actions and activities under different observational conditions, and describing these activities in a larger context.

A full understanding of human actions requires: recognising what action has been performed, predicting how it will affect the surrounding environment, explaining why this action has been performed, and who is performing it . Classic approaches to action recognition interpret a spatio-temporal pattern in a video sequence to tell what action has been performed, and perhaps how and where it was performed. A more complete understanding requires information about why the action was performed, and how it affects the environment. This face of understanding can be provided by explaining the action as part of a narrative.

Most work on recognition of cooking activities has concentrated on recognizing actions from the spatio-temporal patterns of hand motions. While some cooking activities may be directly recognized from motion, the resulting description is incomplete, as it does not describe the state of the ingredients, and how these have been transformed by cooking actions. A fuller description requires a description of how food ingredients have been transformed during the food preparation process.

We have addressed the automatic construction of cooking narratives by first detecting and locating ingredients and tools used in food preparation. We then recognize actions that involve transformations of ingredients, such as "slicing", and use these transformations to segment the video stream into visual events. We can then interpret detected events as a causal sequence of voluntary actions, confirmed by spatio-temporal transformation patterns, in order to automatically provide a narrative.

Our method is inspired by the intuition that object states are visually more apparent than actions from a still frame and thus provide information that is complementary to spatio-temporal action recognition. We define a state transition matrix that maps action labels into a pre-state and a post-state. We identify key frames, and use these to learn appearance models of objects and their states. For recognition, we use a modified form of VGG neural network trained via transfer learning with a specially constructed data set of images of food types and food sates. Manipulation actions are hypothesized from the state transition matrix and provide complementary evidence to spatio temporal action recognition.

4.3. Embedded Computer Vision for low-power Bolometric Imaging

In cooperation with Schneider Electric, we have developed techniques for embedded real time image analysis and tracking algorithms using Bolometric Imaging Sensors. Such sensors capture light in the far infrared and return an image where each pixel is a measurement of temperature in degree centigrade. We have designed an integrated low-cost sensor that combines an 80x80 pixel Bolometric imager with a low power micro-processor. The device provides real-time, embedded image processing for target detection and activity analysis where all sensing and interpretation is local. No images are recorded and only relevant information is about activity is communicated. The design of this system is under consideration for a patent, and thus has not been published. The software system has been registered with French APP , and is to be licensed to Schneider Electric for use a line of sensors for detecting falls and other activities for assisted living for seniors, as well as monitoring customer activities in commercial environments.

4.4. Recognizing and predicting routine activities in smart homes

Most research on smart home systems has concentrated on techniques for recognizing context. However, many categories of service require information about likely future context. We have developed and approach that uses dynamic Bayesian networks to predict future activity and context in a smart home. Our approach extends a state-of-the-art prediction model with three contributions. First, we include sensor data through aggregation nodes, instead of limiting ourselves only to higher level context data. Second, our method uses higher order relations between activities, so that past activities can have a more meaningful impact on prediction of future activities. Third, we use a latent node that estimates the cognitive state of the occupant.

4.5. User centred energy management

Participants: Amr Al-Zouhri Al-Yafi, 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.

4.6. 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.

4.7. 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. Peudo-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.

5. Highlights of the Year

5.1. Highlights of the Year

James Crowley was named to the Chair on Intelligent Collaborative Systems.

6. New Results

6.1. Observing and Modelling Expertise and Awareness from Eye-gaze and Emotion

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

We have constructed an instrument for capturing and interpreting multimodal signals of humans engaged in solving challenging problems. Our instrument captures eye gaze, fixations, body postures, and facial expressions signals from humans engaged in interactive tasks on a touch screen. We use a 23 inch Touch-Screen computer, a Kinect 2.0 mounted 35 cm above the screen to observe the subject, a 1080p Webcam for a frontal view, a Tobii Eye-Tracking bar (Pro X2-60 screen-based) and two adjustable USB-LED for lighting condition control. A wooden structure is used to rigidly mount the measuring equipment in order to assure identical sensor placement and orientation for all recordings.

As a pilot study, we observed expert chess players engaged in solving problems of increasing difficulty]. Our initial hypothesis was that we could directly detect awareness of significant configurations of chess pieces (chunks) from eye-scan and physiological measurements of emotion in reaction to game situation. The pilot experiment demonstrated that this initial hypothesis was overly simplistic.

In order to better understand the phenomena observed in our pilot experiment, we have constructed a model of the cognitive processes involved, using theories from cognitive science and classic (symbolic) artificial intelligence. This model is a very partial description that allows us to ask questions and make predictions to guide future experiments. Our model posits that experts reason with a situation model that is strongly constrained by limits to the number of entities and relations that may be considered at a time. This limitation forces subjects to construct abstract concepts (chunks) to describe game play, in order to explore alternative moves. Expert players retain associations of situations with emotions in long-term memory. The rapid changes in emotion correspond to recognition of previously encountered situations during exploration of the game tree. Recalled emotions guide selection of situation models for reasoning. This hypothesis is in accordance with Damasio's Somatic Marker hypothesis, which posits that emotions guide behavior, particularly when cognitive processes are overloaded.

Our hypothesis is that the subject uses the evoked emotions to select from the many possible situations for reasoning about moves during orientation and exploration. With this interpretation, the player rapidly considers partial descriptions as situations composed of a limited number of perceived chunks. Recognition of situations from experience evokes emotions that are displayed as face expressions and body posture.

With this hypothesis, valence, arousal and dominance are learned from experience and associated with chess situations in long-term memory to guide reasoning in chess. Dominance corresponds to the degree of experience with the recognized situation. As players gain experience with alternate outcomes for a situation, they become more assured in their ability to spot opportunities and avoid dangers. Valence corresponds to whether the situation is recognized as favorable (providing opportunities) or unfavorable (creating threats). Arousal corresponds to the imminence of a threat or opportunity. A defensive player will give priority to reasoning about unfavorable situations and associated dangers. An aggressive player will seek out high valence situations. All players will give priority to situations that evoke strong arousal. The amount of effort that player will expend exploring a situation can determined by dominance.

6.2. Recognition, Modelling and Description of Manipulation Actions

Participants: Nachwa Abou Bakr, James Crowley.

A full understanding of human actions requires: recognizing what action has been performed, predicting how it will affect the surrounding environment, explaining why this action has been performed, and who is performing it. Classic approaches to action recognition interpret a spatio-temporal pattern in a video sequence to tell what action has been performed, and perhaps how and where it was performed. A more complete understanding requires information about why the action was performed, and how it affects the environment. This face of understanding can be provided by explaining the action as part of a narrative.

We have addressed the problem of recognition, modelling and description of human activities, with results on three problems: (1) the use of transfer learning for simultaneous visual recognition of objects and object states, (2) the recognition of manipulation actions from state transitions, and (3) the interpretation of a series of actions and states as events in a predefined story to construct a narrative description.

These results have been developed using food preparation activities as an experimental domain. We start by recognizing food classes such as tomatoes and lettuce and food states, such as sliced and diced, during meal preparation. We adapt the VGG network architecture to jointly learn the representations of food items and food states using transfer learning. We model actions as the transformation of object states. We use recognised object properties (state and type) to detect corresponding manipulation actions by tracking object transformations in the video. Experimental performance evaluation for this approach is provided using the 50 salads and EPIC-Kitchen datasets. We use the resulting action descriptions to construct narrative descriptions for complex activities observed in videos of 50 salads dataset.

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

7.1.1. CIFRE Doctoral Contract with eLichens

The main topic of the project is to develop cloud-based services for Building Management System (BMS) framework. The aim is to develop predictive algorithms to control Heat Ventilation and Air Conditioning (HVAC) systems addressing two main goals:

1. Improve the well-being of the occupants keeping different variables as temperature, humidity, CO2, air quality measures inside a pre established optimal range;
2. Saving costs optimizing energy consumption

This research is supervised by Patrick Reignier.

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. LabEx Persyval, Project RHUM, Robots in Human Environments

Participants: Thierry Fraichard, Patrick Reignier.

Partners: GIPSA, Inria, LIG, LJK and TIMC.
Dates:*[Sep. 15-Dec. 19].*

The RHUM project from the LabEx Persyval (ANR-11-LABX-0025-01) brings together ten teams from different labs from the Grenoble academic scene: GIPSA, Inria, LIG, LJK and TIMC. Its goal is to tackle scientific problems related to active perception, navigation in human environments, learning and adaptation of robots behaviors for social interaction. PERVASIVE contributes to the navigation in human environments aspects.

8.1.2. ExpeSigno

Participants: Patrick Reignier, Amr Al-Zouhri Al-Yafi, Amine Awada.

Projet Région Pack Ambition Recherche EXPESIGNO : Expérimentation de la réactivité des ménages aux signaux des opérateurs de systèmes énergétiques
Other Partners : Laboratoire Gaël, Laboratoire G2ELAb, laboratoire G-Scop
Dates : 2018 - 2022

Buildings represent 66% of electricity consumption and they can act as nodes in a network of consumption, storage and energy production. In this case, it can be understood that buildings and their inhabitants will change from a passive consumer to an active consumer (the so called “pro-sumer”) who can respond quickly to price changes on the network and / or signals from operators, or even other pro-sumers offering energy production and storage solutions using solar panels or electric cars. To achieve this goal, energy systems must send consumers the right signal to induce appropriate local and global behavior. The introduction of equipment such as Smart Meters or interactive consumption management devices is decisive because they are considered as the solution to turn residential consumers into active users of their electricity or energy consumption. Nudges are an interesting way to induce lasting changes in consumer behavior. The idea of nudges is to set up environments of choice that help people make the choices that are best for them. During this project, we are going to deploy sensors within 4 volunteer families in order to study the impact of nudges on electricity consumption through a detailed analysis of the practices carried out. The objective is to establish the links between the sensor data and the activities declared by each household and to measure how nudges influence their activities.

8.1.3. ANR Project CEEGE: Chess Expertise from Eye Gaze and Emotion

Participants: Thomas Guntz, James Crowley, Dominique Vaufreydaz, Raffaella Balzarini.

Other Partners : Dept of NeuroCognition, CITEN, Bielefeld University
Dates : Jan 2016 to Dec 2019

The ANR CEEGE project 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 have observed 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 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 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 has been used to determine and model the degree to which a player understands the game situation in terms of abstract configurations of chess pieces. This provides a structured environment that use for experimental evaluation of current theories of mental modeling and emotional response during problem solving and social interaction.

The project have been organized in two phases. During the first phase, we will observed individual players of different levels of chess expertise solving known chess problems. We correlated scan-path from eye tracking and other information about visual attention to established configurations of pieces and known solutions to chess problems. We constructed 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 have observed the attention and face expressions of pairs of players of different levels of chess ability solving problems followed by verbal self reports. We have used 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.

8.1.4. CDP EcoSesa - Cross Disciplinary Project of the ComUE UGA

Participants: Patrick Reignier, James Crowley, Raffaella Balzarini, Amr Al-Zouhri Al-Yafi.

Funding : UGA Idex Cross disciplinary project
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

8.1.5. ANR VALET

Participant: Dominique Vaufreydaz.

Partners: Inria (Pervasive and Chroma teams for Inria Rhône-Alpes, RITS in Paris), Ircyyn (Nantes), AKKA (Paris)
Dates: 2016-2018

The ANR VALET project investigates two aspects of car sharing. In the first one, a novel approach for solving vehicle redistribution problem is proposed by managing an autonomous platoons guided by professional drivers. The second aspect concerns autonomous parking of shared cars when they arrived at their destination parking lot. In this project, our researches address the prediction of pedestrians' behaviors during urban fleet movements and during parking phases. The PhD student (Pavan Vashista) recruited in this project focus on integrating models of human behaviors to evaluate the risk that surrounding pedestrians encounter the trajectory of the VALET vehicles. His PhD thesis started in February 2016 is co-supervised by Anne Spalanzani (Chroma team) and Dominique Vaufreydaz.

8.1.6. ANR HIANIC

Participant: Dominique Vaufreydaz.

Partners: ARMEN and PACCE teams from LS2N laboratory (Nantes), Inria (Pervasive and Chroma teams for Inria Rhône-Alpes, RITS in Paris), MAGMA from LIG laboratory (Grenoble).
Dates: 2018-2021

The HIANIC project proposes to endow autonomous vehicles with smart behaviors (cooperation, negotiation, socially acceptable movements) to address problems that arise when autonomous cars are mixed with pedestrians in urban shared environment. It aims at developing new technologies in term of autonomous navigation in dense and human populated traffic. In order to contribute to urban safety and intelligent mobility, the HIANIC project also explores the complex problem of sociable interactions between pedestrians and cars while sharing the same urban environment.

In this project, Dominique Vaufreydaz works jointly with the Chroma team on perceiving pedestrians and their behaviors around autonomous cars and on interaction between autonomous vehicles and pedestrians.

8.1.7. LabEx Persyval - Project MicroBayes: Probabilistic Machines for Low-level Sensor Interpretation

Participants: Emmanuel Mazer, Raphael Frisch.

Partners: 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.

8.1.8. Competitivity Clusters

James Crowley is on the scientific committee for the Minalogic Competitivity 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.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. AI4EU - A European AI On-Demand Platform and Ecosystem

Call: H2020 ICT-26-2018-2020
Coordinateur: Thales Systems
Partners: 79 European institutions
Dates: Jan 2019 through Dec 2021

AI4EU will build a comprehensive European AI-on-demand Platform that provides innovators in all areas of society with access to expertise, knowledge, algorithms and tools for developing, deploying and funding innovations based on Artificial Intelligence.

The aim is to empower actors across a broad spectrum of commercial, industrial and societal sectors in Europe with tools for innovation through AI Technologies. By bringing together a whole ecosystem of researchers, innovators, SMEs, large corporations, students and many others, around a single access point to AI resources, we will lower the barriers to education, research and innovation. Moreover, the AI4EU Platform will embrace on European values, respect European laws and support a human-centric approach providing a competitive advantage for European players.

8.2.1.2. H2020 FET Human AI

Call: H2020 FETFLAG-01-2018
Coordinateur: DFKI
Partners: 49 European institutions
Dates:1 March 2019 to 31 May 2020.

Humane AI has been funded to create a European network of centers of excellence for Artificial Intelligence technologies that synergistically work with humans, seamlessly fit in with our complex social settings and dynamically adapt to changes in our environment. The project seeks to develop world-leading insights and AI technologies, from fundamental algorithms, through methods specific to concrete applied AI domains such as Computer Vision, Robotics, IoT, Language Technologies and multi Agent Systems all the way up to disruptive AI applications and broadly usable platforms. Core innovations include (1) tools for enhancing human cognitive capabilities, channeling human creativity, inventiveness and intuition and empowering humans to make important decisions in a more informed way, (2) AI systems that can intelligently interact with and within complex social settings and seamlessly adapt to changing, open-ended environments, (3) explainable, transparent, validated and thus trustworthy AI systems that will help us more effectively deal with the complexity of a networked globalized world and (4) ways to embed values, ethics, privacy and security as core design considerations in all AI systems and applications.

To ensure broad and lasting socio-economic impact in areas which are important to Europe and its citizens on top of the basic research we will implemented dedicated impact-oriented work packages in domains such as Society and Policy, Industry 4.0, Sustainability and Energy, Finance, Science and Education, Health and Mobility/Automotive. To realize the Humane AI vision the consortium has lined up key European players and brought the relevant community on board to mobilize the critical mass needed for success. Many of the partners have strong interdisciplinary research track records, and several PIs on this project hold ERC grants, documenting scientific excellence. With their capability, networks and experience, we have a solid plan to bring the remaining players into the flagship activity during the preparatory action phase.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

8.3.1.1. Sethserey Sam, Vice-Président NIPTICT, Phnom Penh

Position: Vice-Président en charge de la recherche et des relations internationales du NIPTICT, Phnom Penh, Cambodge (et son assistante)
Date: Du 14 au 17 Avril 2019

8.3.1.2. Dr. Dao Trung Kien

Position: Directeur adjoint de l'Institut MICA, HUST, Hanoi, Vietnam

Date: novembre et décembre 2019

Travail sur la thématique de la localisation indoor de personnes grâce aux technologies sans fil et à la fusion intelligente de données hétérogènes.

9. Dissemination

9.1. Promoting Scientific Activities

9.1.1. Scientific Events: Organisation

9.1.1.1. Member of the Organizing Committees

Eric Castelli Co-organised the workshop BREVES (Vietnam, France Belgique), in Hanoi the 5 and 6 november 2019

Sabine Coquilart served as co-chair of the Paper Award committee for IEEE VR 2019 - IEEE Virtual Reality Conference

Sabine Coquilart served as co-chair of the Paper Award committee for SUI 2019 - ACM Spatial User Interaction

James Crowley served as Chairman of the Awards committee for ACM ICMI 2019 - International Conference on Multimodal Interaction.

Eric Castelli served as "board member" of the international conference series SLTU'xx (Spoken Language Technologies for Under-resourced languages)

9.1.1.2. Member of the Conference Program Committees

Sabine Coquilart served on the conference program committee for

- AIVR 2019 - International Conference on Artificial Intelligence and Virtual Reality
- CENTRIC 2019 - The Twelfth International Conference on Advances in Human-oriented and Personalized Mechanisms, Technologies, and Services
- GRAPP 2019 - International Conference on Computer Graphics Theory and Applications
- ICGI 2019 - International Conference on Graphics and Interaction
- ISVC 2019 - International Symposium on Visual Computing
- VRST 2019 - ACM Symposium on Virtual Reality Software and Technology
- WSCG 2019 - International Conferences in Central Europe on Computer Graphics, Visualization and Computer Vision

9.1.2. Scientific Events: Selection

9.1.2.1. Chair of Conference Program Committees

Sabine Coquilart served as co-chair for the paper selection panel for IEEE VR 2019

Sabine Coquilart served as co-chair for the paper selection panel for SUI 2019

9.1.2.2. Reviewer

Sabine Coquilart reviewed papers IEEE World Haptics 2019

Thierry Fraichard reviewed papers IEEE ICRA 2019

James Crowley served as a reviewer for

- ICCV 2019 - International Conference on Computer Vision
- CVPR 2019 - IEEE Conference on Computer Vision and Pattern Recognition
- AAAI 2020 - Association for the Advancement of Artificial Intelligence
- iCMI 2019 - International Conference on Multimodal Interaction.
- IHM 2019 - Interaction Homme Machine

Eric Castelli served as a reviewer for

- SigTelCom 2019 (Hanoi, Vietnam)
- ICVES 2019 (Cairo, Egypt)
- ISEE2019 (Ho Chi Minh City, Vietnam)
- SPECOM 2019 (Istanbul, Turkey)
- SCS'19 (Kingdom of Bahrain)
- ATC2019 (Hanoi, Vietnam)
- ICMSAO2019 (Bahrain)
- IALP2019 (Taipei, Taiwan)
- SoICT 2019 (Hanoi & HaLong Bay, Vietnam)
- 3ICT'19 (Kingdom of Bahrain)
- NICS 2019 (Hanoi, Vietnam)
- FLAIRS'33 2020 (North Miami Beach, USA)
- ICWMC 2020 (Athens, Greece)
- LREC 2020 (Marseille, France)
- MAPR 2020 (Hanoi, Vietnam)

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.
Sabine Coquilart is a member of the Scientific Committee of the Journal of Virtual Reality and Broadcasting.

9.1.3.2. Reviewer - Reviewing Activities

Sabine Coquilart reviewed papers for IEEE Transactions on Haptics
Thierry Fraichard reviewed papers for IEEE Trans. Robotics and Automation (TRO)
James Crowley reviewed papers for Communications of the ACM

9.1.4. Invited Talks

James Crowley gave the following invited talks:

- **Artificial Intelligence: a Rupture Technology for Innovation**, invited lecture at Club des DIS, Dirigeants Innovation et Stratégie, Montbonnot, 14 March 2019.
- **Collaborative Intelligent Systems**, invited lecture at Simula Research Institute, Oslo Norway, Montbonnot, 27 September 2019.
- **Artificial Intelligence: a Rupture Technology for Innovation**, AI4EU Web Cafe (webinar), 13 November 2019
- **Artificial Intelligence for Human Computer Interaction**, Keynote lecture at IHM 2019, Grenoble 12 Dec 2019.

Eric Castelli gave the invited talk

- **Multimodal perception and Pervasive spaces for Sociable interaction** International workshop BREVES, USTH, Hanoi, Vietnam, 5 and 6 November 2019.

9.1.5. Leadership within the Scientific Community

Sabine Coquilart is elected member of the EUROGRAPHICS Executive Committee.
Sabine Coquilart is co-chair of the EUROGRAPHICS Working Group and Workshop board.
Sabine Coquilart is co-chair of the Steering Committee for EGVE - Eurographics Working Group on Virtual Environments
James Crowley is a member of the Steering Committee for ICMI - International Conference on Multimodal Interaction.

9.1.6. *Scientific Expertise*

Patrick Reignier is a member of the Scientific Council of the Amiqual4Home EquipEx.
Thierry Fraichard served as an expert reviewer for the European Commission, the IDEX of Aix-Marseille Université, and the IDEX of Université Grenoble Alpes

9.1.7. *Research Administration*

Thierry Fraichard is a member of the following Inria committees:

- Research Center Committee (CC), IT Service Committee (CUMI), and Technological Development Committee (CDT).

James Crowley is an elected member of the Conseil d'Administration of the Comue Univ Grenoble Alpes
James Crowley Served on the Bureau (executive committee) of the laboratoire LIG
Patrick Reignier is head of the engineering support group of the Laboratoire d'Informatique de Grenoble (13 members).
Patrick Reignier serves on the Administrative Office (Bureau) for the Laboratoire Informatique de Grenoble.
Patrick Reignier is at the head of the Domus Living Lab
Patrick Reignier is a member of the Comité Executif of the Amiqual4Home Equipex
Patrick Reignier is a member of the Comité de pilotage of the MACI (Maison de la Création et l'Innovation)

9.2. Teaching - Supervision - Juries

Patrick Reignier teaches

- elected member of the Conseil des Etudes et de la Vie Universitaire of Grenoble INP
- nominated as a member of the Conseil de la Formation Continue de Grenoble INP
- co-director of the "formation en apprentissage" of Ensimag (3 years program : 1 year for the Licence and 2 years for the Master)
- Supervises the industrial part of the “formation en apprentissage” of the Ensimag engineering school.

James Crowley and **Dominique Vaufreydaz** co-direct the Graphics - Vision - Robotics Specialisation of the MoSIG M2 Masters.

9.2.1. *Teaching*

James Crowley teaches

- M2 MoSIG Computer Vision
- ENSIMAG 3 Machine Learning.
- M1 MoSIG Intelligent Systems.
- ENSIMAG 2 Intelligent Systems.

Patrick Reignier teaches

- Projet Genie Logiciel, 55h eqTD, M1, Ensimag/Grenoble INP, France.
- Développement d'applications communicantes, 18h eqTD, M2, Ensimag/Grenoble-INP, France
- Introduction aux applications reparties, 18h eqTD, M2, Ensimag/Grenoble- INP, France
- Applications Web et Mobiles , 27h eqTD, M1, Ensimag/Grenoble-INP, France
- Projet Systeme, 12h eq TD, M1, Ensimag/Grenoble-INP, France
- Projet C, 20h eqTD, L3, Ensimag/Grenoble-INP, France.

Thierry Fraichard, taught Autonomous Robotics, 22.5h eqTD, M2 MOSIG, Univ. Grenoble Alpes.

9.2.2. *Supervision*

Thierry Fraichard directed the following Doctoral students

- Jose Grimaldo Da Silva Filho, "Human-Robot Motion, a Shared Effort Approach", Octobre 2015, Thierry Fraichard and James Crowley.
- Matteo Ciocca, "Safe Robot Motion", Octobre 2016, Thierry Fraichard and Pierre-Brice Wieber.

James Crowley directed the following Doctoral students

- Nachwa Abou Bakr, "Recognition, Modeling and Description of Manipulation actions "
- Thomas Guntz, "Estimating Expertise from Eye Gaze and Emotions", co-directed with Dominique Vaufreydaz

9.2.3. Juries

Patrick Reignier served as a president of the Doctoral Jury for

- Van Bao Nguyen
- Alessandro Fenicio

James Crowley served as a president of the Doctoral Jury for

- Mathieu Barbier
- David Sierre Gonzalez

9.3. Interventions

Thierry Fraichard participated to the event "A robot on trial", mock trial of a futuristic robot as part of the Transfo digital festival, Jan. 19. This successful event attracted around 200 participants

10. Bibliography

Major publications by the team in recent years

[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", June 2018, vol. 126, n^{o} 6, pp. 571–596, https://arxiv.org/abs/1612.04631 [*DOI :* 10.1007/s11263-017-1052-4], https://hal.inria.fr/hal-01415027

[2] J. COUTAZ, J. L. CROWLEY. *A First-Person Experience with End-User Development for Smart Homes*, in "IEEE Pervasive Computing", May 2016, vol. 15, pp. 26–39 [*DOI :* 10.1109/MPRV.2016.24], https://hal.inria.fr/hal-01422364

[3] T. FRAICHARD, R. PAULIN, P. REIGNIER. *Human-Robot Motion: An Attention-Based Navigation Approach*, in "IEEE RO-MAN", Edinburgh (UK), August 2014, Best Paper Award Nominee [*DOI :* 10.1109/ROMAN.2014.6926332], http://hal.inria.fr/hal-01018471

[4] T. GUNTZ, J. L. CROWLEY, D. VAUFREYDAZ, R. BALZARINI, P. DESSUS. *The Role of Emotion in Problem Solving: First Results from Observing Chess*, in "ICMI 2018 - Workshop at 20th ACM International Conference on Multimodal Interaction", Boulder, Colorado, United States, October 2018, pp. 1-13, https://arxiv.org/abs/1810.11094 , https://hal.inria.fr/hal-01886694

[5] P. VASISHTA, D. VAUFREYDAZ, A. SPALANZANI. *Building Prior Knowledge: A Markov Based Pedestrian Prediction Model Using Urban Environmental Data*, in "ICARCV 2018 - 15th International Conference on Control, Automation, Robotics and Vision", Singapore, Singapore, November 2018, pp. 1-12, Best Student Paper Award, https://hal.inria.fr/hal-01875147

Publications of the year

Articles in International Peer-Reviewed Journals

[6] A. Alzouhri Alyafi, M. Pal, S. Ploix, P. Reignier, S. Bandyopadhyay. *Unmasking the causal relationships latent in the interplay between occupant's actions and indoor ambience: a building energy management outlook*, in "Applied Energy", January 2019, vol. 238, pp. 1452-1470 [*DOI :* 10.1016/j.apenergy.2019.01.118], https://hal.archives-ouvertes.fr/hal-01984833

[7] M. Bouguerra, T. Fraichard, M. Fezari. *Viability-Based Guaranteed Safe Robot Navigation*, in "Journal of Intelligent and Robotic Systems", August 2019, vol. 95, n^o^ 2, pp. 459–471 [*DOI :* 10.1007/s10846-018-0955-9], https://hal.inria.fr/hal-01924855

[8] T. Fraichard, V. Levesy. *From Crowd Simulation to Robot Navigation in Crowds*, in "IEEE Robotics and Automation Letters", April 2020, vol. 5, n^o^ 2, pp. 729-735 [*DOI :* 10.1109/LRA.2020.2965032], https://hal.inria.fr/hal-02461493

[9] G. Nieto, F. Devernay, J. L. Crowley. *Rendu basé image avec contraintes sur les gradients*, in "Traitement du Signal", 2019, pp. 1-26, forthcoming [*DOI :* 10.3166/HSP.x.1-26], https://hal.archives-ouvertes.fr/hal-01900200

[10] R. Paulin, T. Fraichard, P. Reignier. *Using Human Attention to Address Human-Robot Motion*, in "IEEE Robotics and Automation Letters", February 2019, vol. 4, n^o^ 2, pp. 2038-2045, The content of this paper was also selected by the Program Committee for presentation at the IEEE Int. Conf. On Robotics and Automation (ICRA), May 2019, Montréal (CA) [*DOI :* 10.1109/LRA.2019.2899429], https://hal.inria.fr/hal-02013578

[11] V.-C. Ta, T.-K. Dao, D. Vaufreydaz, E. Castelli. *Collaborative Smartphone-Based User Positioning in a Multiple-User Context Using Wireless Technologies*, in "Sensors", January 2020, 25 p. [*DOI :* 10.3390/s20020405], https://hal.inria.fr/hal-02435610

International Conferences with Proceedings

[12] M. Ciocca, P.-B. Wieber, T. Fraichard. *Effect of Planning Period on MPC-based Navigation for a Biped Robot in a Crowd*, in "IROS 2019 - IEEE/RSJ International Conference on Intelligent Robots and Systems", Macau, China, IEEE, November 2019, pp. 1-8 [*DOI :* 10.1109/IROS40897.2019.8968070], https://hal.inria.fr/hal-02267426

[13] J. G. Da Silva Filho, A.-H. Olivier, A. Crétual, J. Pettré, T. Fraichard. *Effective Human-Robot Collaboration in near symmetry collision scenarios*, in "RO-MAN 2019 - 28th IEEE International Conference on Robot & Human Interactive Communication", New Dehli, India, IEEE, October 2019, pp. 1-8, https://hal.inria.fr/hal-02267705

[14] R. Frisch, M. Faix, J. Droulez, L. Girin, E. Mazer. *Bayesian time-domain multiple sound source localization for a stochastic machine*, in "EUSIPCO 2019 - 27th European Signal Processing Conference", A Coruna, Spain, IEEE, September 2019, pp. 1-5 [*DOI :* 10.23919/EUSIPCO.2019.8902666], https://hal.archives-ouvertes.fr/hal-02377220

[15] J. Le Louedec, T. Guntz, J. L. Crowley, D. Vaufreydaz. *Deep learning investigation for chess player attention prediction using eye-tracking and game data*, in "ETRA 2019 - ACM Symposium On Eye Tracking

Research & Applications", Denver, United States, ACM, June 2019, pp. 1-15, https://arxiv.org/abs/1904.08155 [*DOI :* 10.1145/3314111.3319827], https://hal.inria.fr/hal-02100389

National Conferences with Proceedings

[16] M. TROEL-MADEC, J. ALAIMO, L. BOISSIEUX, S. CHATAGNON, S. BORKOSWKI, A. SPALANZANI, D. VAUFREYDAZ. *eHMI positioning for autonomous vehicle/pedestrians interaction*, in "IHM 2019 - 31e conférence francophone sur l'Interaction Homme-Machine", Grenoble, France, ACM, 2019, pp. 1-8 [*DOI :* 10.1145/3366551.3370340], https://hal.archives-ouvertes.fr/hal-02388847

Conferences without Proceedings

[17] N. ABOUBAKR, J. L. CROWLEY, R. RONFARD. *Recognizing Manipulation Actions from State-Transformations*, in "EPIC@CVPR 2019 - Fourth International Workshop on Egocentric Perception Interaction and Computing", Long Beach, United States, June 2019, pp. 1-4, https://arxiv.org/abs/1906.05147 - Accepted for presentation at EPIC@CVPR2019 workshop, https://hal.archives-ouvertes.fr/hal-02197549

[18] F. PORTET, S. CAFFIAU, F. RINGEVAL, M. VACHER, N. BONNEFOND, S. ROSSATO, B. LECOUTEUX, T. DESOT. *Context-Aware Voice-based Interaction in Smart Home -VocADom@A4H Corpus Collection and Empirical Assessment of its Usefulness*, in "PICom 2019 - 17th IEEE International Conference on Pervasive Intelligence and Computing", Fukuoka, Japan, 2019 IEEE Intl Conf on Dependable, Autonomic and Secure Computing, Intl Conf on Pervasive Intelligence and Computing, Intl Conf on Cloud and Big Data Computing, Intl Conf on Cyber Science and Technology Congress, IEEE, August 2019, pp. 811–818 [*DOI :* 10.1109/DASC/PICOM/CBDCOM/CYBERSCITECH.2019.00149], https://hal.archives-ouvertes.fr/hal-02165532

Research Reports

[19] N. ABOUBAKR, J. CROWLEY, R. RONFARD. *Recognizing Manipulation Actions from State-Transformations (Technical Report)*, Univ. Grenoble Alps, CNRS, Inria, Grenoble INP, LIG, 38000 Grenoble, France, June 2019, https://hal.archives-ouvertes.fr/hal-02197595

[20] R. BALZARINI. *Rapport d'étude campagne expérimentale -exploratoire -pour l'étude de l'attention visuelle en eye-tracking projet COM2SICA*, Inria GRA, Laboratoire GéoAzur CNRS, UMR Espace, November 2019, https://hal.inria.fr/hal-02388358

Scientific Popularization

[21] R. LAURENT, D. VAUFREYDAZ, P. DESSUS. *Ethical Teaching Analytics in a Context-Aware Classroom: A Manifesto*, in "ERCIM News", January 2020, n° 120, pp. 39–40, https://hal.archives-ouvertes.fr/hal-02438020

Other Publications

[22] M. TROEL-MADEC. *Concilier les comportements intentionnels du véhicule autonome et du piéton*, Pôle supérieur de Design Léonard de Vinci, 38090 Villefontaine, France, June 2019, https://hal.inria.fr/hal-02274535