1 Equipe IIHM - Axe Systèmes Interactifs et Cognitifs

1.1 Scientific Presentation

Scientific leader: Laurence Nigay Web site: iihm.imag.fr/en/
Parent Organizations: CNRS, Grenoble INP, U. Grenoble 1 (UJF), U. Grenoble 2 (UPMF).

1.1.1 Group Members

Permanent members (2014-06-30)				
last name	first name	position	institution	arrival
Bérard	François	Associate Professor	G-INP	Jan. 01
Blanch	Renaud	Associate Professor	UJF	Sep. 06
Caffiau	Sybille	Associate Professor	UJF	July 12
Calvary	Gaëlle	Full Professor, 2nd class	G-INP	Jan. 00
Coutaz	Joëlle	Professor Emeritus	UJF	Sep. 73
Coutrix	Céline	Researcher	CNRS	Sep. 10
Dupuy-Chessa	Sophie	Associate Professor	UPMF	Sep. 02 [a]
Laurillau	Yann	Associate Professor	UPMF	Sep. 07
Nigay	Laurence	Full Professor, exceptional class	UJF	Sep. 94
Ortega	Michael	Research Engineer, Part time	CNRS	Sep. 10
Tarpin-Bernard	Franck	Full Professor, 2nd class	UJF	Sep. 09 [b]

[a] since Sep. 08, 50% IIHM, 50% SIGMA
[b] from Sep. 13 to Aug. 15 in delegation at Scientific Brain Training S.A

1.1.2 Group evolution

The composition of the IIHM research group has changed during the reporting period as follows, in chronological order:

- Franck Tarpin-Bernard joined in September 2009 as a Professor.
- Gaëlle Calvary was promoted to Professor at G-INP in September 2009.
- François Bérard was a Visiting Scientist at McGill University (Centre for Intelligent Machines) from September 2009 to December 2009.
- Laurence Nigay is the head of the IIHM research group since September 2009.
- Renaud Blanch was a Visiting Scientist ("délégation après service") at Instituto de Computación, Universidad de la República Montevideo-Uruguay between August 2010 and December 2010.
- Céline Coutrix joined in October 2010 as a CNRS research scientist.
- Michael Ortega joined in September 2010 as a CNRS research engineer part time.
- Sophie Dupuy-Chessa defended the Habilitation thesis on December 2011.
- Sybille Caffiau joined in July 2012 as Assistant Professor when the Multicom research group of LIG was terminated.
- Joëlle Coutaz, founder of the IIHM group, is Professor Emeritus since September 2012.
- Michael Ortega was a Visiting Scientist at York University (Pr. Wolfgang Stuerzlinger) between October 2013 and November 2013.
- Renaud Blanch is on leave (delegation at CNRS) from September 2013 until September 2014. He was a Visiting Scientist at École Supérieure de Technologie (Montréal, Canada) in March 2014.
- Franck Tarpin-Bernard is on leave (delegation at Scientific Brain Training S.A) from September 2013 until September 2015.

Doctoral students (2014-06-30)					
last name	first name	reg.	university	supervisor	funding
Bouzit	Sarah	Jan. 14	Grenoble	G. Calvary 50% D. Chêne (Orange) 50%	CDD Orange Labs
Brouet	Rémi	Oct. 10	Grenoble	R. Blanch 50% M.-P. Cani (LJK) 50%	MESR
Céret	Eric	Nov. 10	Grenoble	G. Calvary 50% S. Dupuy-Chessa 50%	Investissement d'Avenir BGLE
Dautriche	Rémy	Nov. 13	Grenoble	R. Blanch 50% A. Termier (HADAS) 50%	CIFRE ST MicroElectronics
Delamare	William	Oct. 11	Grenoble	C. Coutrix 50% L. Nigay 50%	FUI
Foulonneau	Anthony	Nov. 13	Grenoble	G. Calvary 50% E. Vilain (Orange) 50%	CDD Orange Labs
Guillon	Maxime	Feb. 13	Grenoble	L. Nigay 50% F. Leitner (Aesculap) 50%	CIFRE Aseculap
Johal	Wafa	Oct. 12	Grenoble	G. Calvary 30% S. Pesty (MAGMA) 70%	ANR (MAGMA group)
Kos'myna	Nataliya	Oct. 12	Grenoble	F. Tarpin-Bernard 50% R. Blanch 50%	SEI-Grenoble INP
Martinet	Morgan	Dec 12	Grenoble	L. Nigay 50% P. Lalanda (ADELE) 50%	Industrial contracts (ADELE group)
Martins-Baltar	Laure	Oct. 11	Grenoble	G. Calvary 50% Y. Laurillau 50%	ANR Tecsan
Masson	Dimitri	Sept. 10	Grenoble	G. Calvary 50% A. Demeure (PRIMA) 50%	ATER UPMF
Oliveira	Raquel	Oct. 12	Grenoble	G. Calvary 10% S. Dupuy-Chessa 40% H. Garavel (CONVECS) 40% F. Lang (CONVECS) 10%	Investissement d'Avenir BGLE
Pelurson	Sébastien	Jan. 13	Grenoble	L. Nigay 100%	CIFRE Motwin
Rousset	Elisabeth	May 13	Grenoble	F. Bérard 50% M. Ortega 50%	FUI
Vincent	Thomas	Oct. 11	Grenoble	L. Nigay 75% T. Kurata (AIST Japan) 25%	ANR Research International

Temporary personnel (2014-06-30)						
Nguyen	Phi Bang	Engineer	G-INP	July 13	June 14	FUI
Janssoone	Thomas	Engineer	UJF	Feb. 13	May 14	FUI

Visitors for two months or more (2009-01-01 – 2014-06-30)					
Ditmar	Anke	Invited Professor	U. Rostock, Germany	Jan. 12	Feb. 12
Koehly	Rodolphe	Post-doc	U. McGill, Canada	Jan. 13	June 13
Korogi	Masaktsu	Research Scientist	AIST Tsukuba, Japan	Sept. 11	Aug. 12
Makita	Koji	Research Scientist	AIST Tsukuba, Japan	Feb. 13	March 13

Habilitation theses defended (2009-01-01 – 2014-06-30)				
Dupuy-Chessa	Sophie	Associate Professor	UPMF	Dec. 11

1.1.3 Research Description

The IIHM research group is primarily concerned with interactive systems that match users' needs and capabilities. Its scientific project is to elaborate new concepts, models and software tools for designing, implementing, and evaluating interaction techniques and interactive systems that are easy to learn and provide for efficient use in various situations (usability dimensions) as well as to enhance users' experience (aesthetic and affective dimensions). Over the last 15 years, we have observed the proliferation of communicating devices and the progressive merging of physical and digital worlds. In this context, whereas Weiser's exciting vision is being validated, we are facing new research challenges and opportunities for HCI to improve the usability and user experience of the dynamic interconnected physical-digital environments in which multiple users are involved (ubiquitous/pervasive computing or ambient intelligence).

Structured into five research themes, our scientific project both expands graphical user interfaces and focuses on new interaction possibilities for ambient intelligence: (1) Novel Interaction Techniques for GUI (2) Multimodal Interaction (3) User Interface Plasticity (4) Mixed Reality Interaction (5) Mobile Interaction

Although the **IIHM group activities are structured along five main themes** (some of them having dedicated conferences and journals in the HCI community), our research studies and projects quite often span several themes. Clearly, the themes enable us to present the main research activities of the IIHM group but do not in any way (studies/projects and members) define five sub-groups. The contribution and collaboration between the group members on different themes guarantees a strong scientific consistency of the IIHM group in covering significant issues in HCI.

IIHM adopts **a research approach that fruitfully combines conceptual (or analytical) and empirical studies**. IIHM is pivotal in establishing conceptual problem spaces and taxonomies for a particular problem (e.g., [7] [9] [31]). IIHM also adopts an empirical research approach by conducting both controlled laboratory experiments [1] [3] [4] and in-field evaluations [21][22] to study interaction. In addition, a unique specificity of IIHM is to address research problems at different levels of abstraction and granularity. Typically, IIHM contributions cover the:

- **System level** (task analysis [35], development methods/processes [7], UI plasticity and End-User Development [32], autonomic multimodal systems [2])
- **User Interface (UI) level** (self-explanatory UI [8], identity-aware UI [13]),
- **Widget level** (generic UI elements including menu [33], mixed object [29]),
- **Interaction technique level** (brain-computer interaction [11], pointing techniques with distractors [28], distant pointing techniques [1], physical pointing [10], handheld AR [18])
- **Device and sensory-motor phenomenon level** (latency estimators [5], user precision in touch pointing [20]).

The main results address research issues at these different levels of abstraction. We present them along our five themes and we only cite the corresponding **publications rated A/A+** and published during the reporting period.

1.2 Scientific and Technological Results

1.2.1 Novel Interaction Techniques for GUI

This theme focuses on interaction techniques that improve Graphical User Interface (GUI) interaction. We are studying on-the-desktop interaction as well as tabletop and distant interaction for basic generic tasks including exploration of large information spaces and target acquisition.

On-the-desktop: We have continued our work on **interactive information visualization** (visualization of large dendrograms –Figure 1.2.1). At the device/sensory-motor phenomenon level, we have introduced the concept of a **device's human resolution** [27]. Focusing on **target acquisition techniques**, we conducted a study on **distractors** (i.e., potential targets that are not the goal of the user) that lead to an extension of Fitts' paradigm [28]. This is an important general result since the use of this protocol will allow fairer comparisons between pointing techniques (result applied for evaluating distant pointing techniques in [1] (Figure 1.2.1)). **3D interaction** is a new research axis successfully developed during the reporting period that has been further reinforced with the arrival of M. Ortega in 2010. We have obtained results both at the device/sensory-motor phenomenon level (e.g., AirMouse [40]) as well as at the interaction technique level: For recurrent basic 3D tasks, we have proposed techniques for pointing at 3D objects [14] [15] (Figure 1.2.1) [37], for drawing on 3D shapes [3] or for 3D placement [37]. We are also exploring 3D interaction on multi-touch surfaces.

Beyond the desktop: Since the seminal work of F. Bérard with the magic table (2003) on augmented surfaces, we have been working on interaction techniques for tabletop/touch surfaces. At the device/sensory-motor phenomenon level, we have conducted studies on latency [5] and defined two novel approaches to estimate the **latency of touch systems** (Figure 1.2.1). We have also studied the **linear and rotational user's precision** of touch pointing. Such results on user's precision can be applied both to large touch surfaces as well as to touch-based mobile devices (Mobile Interaction theme). Key results

also include innovative **3D interaction techniques** for creating and editing 3D content on multi-touch surface [6] and for 3D rotation with two fingers of a single hand [4]. Finally, we have initiated work on **distant pointing** in the context of augmented surgery (collaboration with Aesculap-Bbraun company). Focusing on the ballistic motion of the pointing task, we have investigated static feedforward and dynamic feedback for target expansion (Figure 1.2.1) [1].

This theme, Novel interaction techniques for GUI, is strongly related to the Mobile Interaction theme (section 1.2.5) and to the following theme on multimodal interaction (section 1.2.2) when combined modalities are used to interact with 2D/3D GUI. This is for example the case of the rake cursor [36] that combines direct manipulation and eye gaze position.

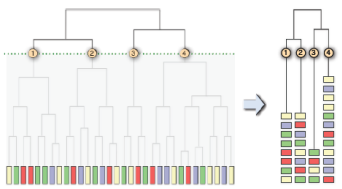

Figure 1: Stacked trees for large dendrograms.

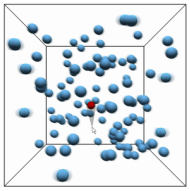

Figure 2: Hook in action in dense environments and fast-moving 3D targets.

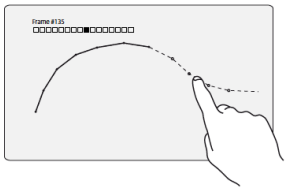

Figure 3: Measuring latency. Latency is the time it will take for the event trajectory to reach the current physical finger position.

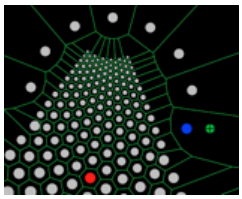

Figure 4: VTE (Static Voronoi-Based Target Expansion) technique for distant pointing with distractors.

Participants: F. Bérard, R. Blanch, Y. Laurillau, L. Nigay, M. Ortega **Doctoral students:** R. Brouet, R. Dautriche, M. Guillon, E. Rousset, T. Vincent **Thesis defended:** G. Bailly **Video demonstrations:** AirMouse, Flower/Leaf/MTM/Wave menus, Rake Cursor, Tabletop Zoomable Treemaps

1.2.2 Multimodal Interaction

Multimodality is one of the foundational research areas of the group, and still remains a key area in our research activity. Focusing on input multimodal interaction, IIHM had two primary goals during this reporting period: first, the exploration of two innovative modalities for HCI, brain-computer interaction and muscle-computer interaction. Second, the provision for generic concepts, models, methods, and tools to harness the diversity of modalities with a focus on specification and development of multimodal interaction.

Brain-computer interaction (Figure 1.2.2) and **muscle-computer interaction** (Figure 1.2.2): This new research topic for IIHM was initiated by F. Tarpin-Bernard who joined the group in 2009. Our approach focuses on brain/muscle computing for human-computer interaction: (1) For facing the current limitations of brain-computer interaction (BCI), especially with consumer-grade hardware, a promising approach that we adopted was the use of BCI in multimodal interaction to achieve either redundancy or complementarity (for instance in [11], combination of BCI with eye-tracking for gaming). (2) In order to further support the use of EEG and EMG in the real-world context we have reduced the need for training and calibration while maintaining the accuracy of the modality [12] [16] [17].

Engineering multimodal interaction: Over the last twenty years, the IIHM group has pioneered the research in engineering multimodal interaction. In particular, we have provided a number of reference models including the CARE properties [41], generic fusion mechanisms [39], software architecture model and software tools [41]. Our participation in several international projects on multimodal interaction (for instance the FP6 OpenInterface project on a open-source software platform that finished in 2009 and was coordinated by IIHM) as well as our international publications on this topic indicate that IIHM is a key player in this area. In this reporting period, we have extended our work on **multimodal interaction to the context of collaborative work**: (1) hierarchical state machines to specify identity awareness and simultaneous user inputs [13] (2) COMM notation [35] for specifying and capturing the relevant dimensions of multimodal collaborative interaction along with an on-line editor e-COMM (Figure 1.2.2). Based on our extensive experience on software tools for multimodal interaction and in collaboration with the ADELE group, who are experts in autonomic runtime environments (a well established collaboration for more than five years), we are also focusing on an **autonomic software framework** (Figure 1.2.2), namely DynaMO [26], for the management of **multimodal interaction in pervasive environments**

[2] [19]. This study is directly related to the End-User Programming approach that we describe in the following theme "User Interface Plasticity".

Figure 5: Brain-computer interaction: game application.

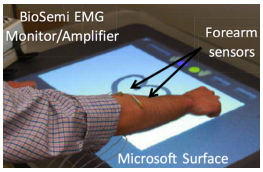

Figure 6: Muscle-computer interaction combined with touch interaction.

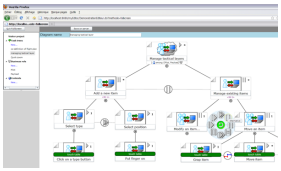

Figure 7: e-COMM graphical editor.

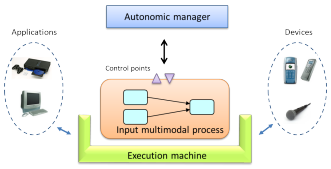

Figure 8: DynaMo: Autonomic management of multimodal interaction.

Participants: R. Blanch, Y. Laurillau, L. Nigay, F. Tarpin-Bernard **Doctoral students:** N. Kos'myna, M. Martinet **Thesis defended:** P.-A. Avouac, F. Jourde, M. Serrano **Video demonstrations:** CubTile, e-COMM, OpenInterface, Rake Cursor

1.2.3 User Interface Plasticity

Plasticity (Figure 1.2.3) refers to the capacity of UIs to withstand variations of the context of use (user, platform, environment) while preserving human-centered values. IIHM has initiated this theme fifteen years ago with the publication of a research agenda at Interact 99. Since then, we have attained a leading position in this area, especially by the promotion of Model Driven Engineering (MDE) and more specifically of models at runtime for plasticity.

Plasticity and MDE: Although a common practice in HCI, MDE has provided the HCI community on plastic UI with useful concepts for framing its own research agenda [32]. Together with the University catholique of Louvain, IIHM defined the **CAMELEON reference framework** for the development of plastic UIs. Based on this now well-established contribution,we have been invited by the W3C to participate to a **standardization action** (the Model Based User Interface group), as part of the European project ITEA2 UsiXML: in particular we have contributed to the task and abstract UI metamodels. The IIHM expertise on MDE, in particular task models (K-MAD notation), has been reinforced by the venue of Sybille Caffiau who joined the group in July 2012. For models, one of our driving principles is to blur the distinction between the development stage and the runtime phase: In ubiquitous computing, neither the user's task nor the functional core can anymore be considered as static, predefined at design time: this breaks two strong implicit hypotheses always done so far. Thus we have tackled two new challenges: the dynamic **composition of UIs** by planning, and the UI plasticity capabilities to support the dynamic and ubiquitous provision of services in **cloud computing**.

Beyond plasticity: We initiated three research topics that take benefit from the MDE approach while going beyond plasticity. First, we have investigated a potentially powerful side effect of maintaining models alive at runtime: the possibility of enriching the **UIs with explanations** directly generated from these models [8] [23] (Figure 1.2.3). Second, we have contributed to the engineering of UIs from a methodological point of view by: (1) stretching the use of models up to the early design phase to foster **creativity** by exploring the design space: we have explored this by coupling MDE with interactive genetic algorithms; (2) studying **flexibility in design/development process**: we have established a taxonomy for design processes [7] and we have defined a metamodel M2Flex that promotes flexibility at design time and at runtime; (3) exploring worth centered design for going beyond usability and achieving the very human-centered values as claimed in our definition of plasticity [short paper at IUI 2013; Work-in-Progress CHI 2014]. Finally, the risk is that UI plasticity based on MDE will be designed for the specialists. We need to put the power in the people's hands [Short paper at NordiCHI 2010] and explore the potential from **End-User Development** (EUD). We are studying EUD in the context of smart homes (Figure 1.2.3) (in ANR CONTINUUM project 2008-11, then in the on-going European Catrene project AppsGate 2012-15). The equipex Amiqual4Home provides IIHM with a fantastic platform to build experiments and perform in-field experiments.

Participants: S. Caffiau, G. Calvary, J. Coutaz, S. Dupuy-Chessa, Y. Laurillau **Doctoral students:** S. Bouzit, E. Ceret, M. Dimitri, A. Foulonneau, W. Johal, L. Martins-Baltar, D. Masson, R. Oliveira

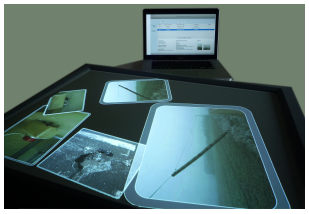

Figure 9: A plastic e-service for declaring incidents in public areas.

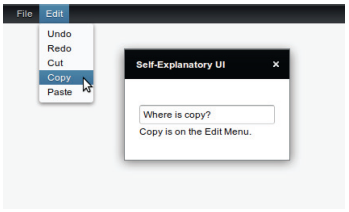

Figure 10: Example of a Model-Driven help UI.

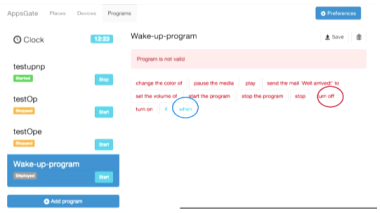

Figure 11: End-User Development in the context of smart homes.

Thesis defended: F. Camara, E. Fontaine, Y. Gabillon, A. Garcia Frey, V. Ganneau, C. Martin, J. Perez-Medina **Video demonstrations:** AppsGate, PhotoBrowser, Plasticité en action, UsiComp

1.2.4 Mixed Reality Interaction

Mixed Reality (MR) interactive systems seek to smoothly merge physical and digital worlds. Examples include tangible user interfaces (TUI), augmented reality (AR), augmented virtuality (AV), physical interfaces and embodied interfaces. Several interaction paradigms therefore fall into MR and we clarified the domain by distinguishing between **augmented virtuality and augmented reality** (Interact 99). Our key contributions are both conceptual in a domain still mainly driven by technologies and practical with interaction techniques and software tools.

At the system and user interface levels, we have elicited the principles of our method Symphony for the **development process of MR systems** [24] [34]. We have also studied mixed reality combined with affective computing: the augmentation of the physical world is based on recognized emotions modeled as an interaction modality, in the context of danced performance [21]. This study on augmenting live dance performance (Figure 1.2.4) drew from several in-field evaluations with dancers as part of the CARE ANR project that has been selected as an ANR highlight project.

Complementary to these studies on MR as systems, we have focused on elementary objects ("widgets") as components of these systems. We have introduced a new way of thinking about interaction design with mixed systems in terms of **mixed objects** (Figure 1.2.4): we have defined the Mixed Interaction Model (MIM) and the OP toolkit whose underlying model is MIM [29].

At the interaction technique level, we have explored two complementary avenues for interacting with the physical world: **handheld augmented reality** (Figure 1.2.4) and **physical interaction** (Figure 1.2.4). With and without a handheld device, we focused on the basic task of pointing at a physical augmented object. At the conceptual level, we have established a design space for disambiguation when directly pointing at physical objects [9] and we have focused on the key concept of spatial relationships for handheld AR [18]. We have designed and evaluated interaction techniques [10] [18] by performing both in-laboratory and in-field experiments (e.g., Schneider production plants).

At the sensory-motor phenomenon level, we have studied the effect of **hand tremor** and **registration jitter** on spatial relations in order to design more precise pointing techniques (Figure 1.2.4): presented at IHM 2013, this work has been awarded best long research paper.

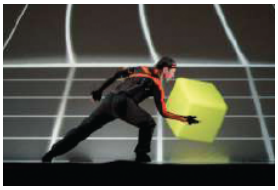

Figure 12: Augmenting live performance.

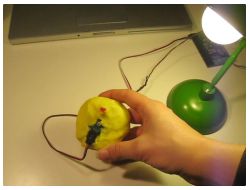

Figure 13: A mixed object sensible to light and built with OP.

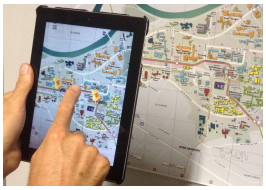

Figure 14: Precise pointing for handheld MR.

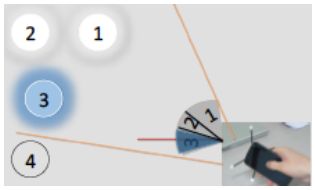

Figure 15: Physical interaction to control light sources.

Participants: S. Dupuy-Chessa, C. Coutrix, L. Nigay, **Doctoral students:** W. Delamare, T. Vincent **Thesis defended:** A. Clay, C. Coutrix, G. Gauffre, G. Godet-Bar **Video demonstrations:** Handheld AR/AV, OP toolkit

1.2.5 Mobile Interaction

Addressing a particular interaction context, this theme is fully orthogonal to the other themes: for instance as part of previous themes, we have presented contributions on touch interaction for 3D rotations on mobile devices [4], physical interaction with a mobile device [10] and handheld AR [18]. In the very dynamic domain of mobile interaction, the objective of IIHM is to contribute to the emergence of a more solid foundation through the development of rapid prototyping tools complemented with empirical studies of innovative interaction techniques.

Innovative interaction techniques and widget: The designed interaction techniques address challenges specific to mobile devices. First, since mobile devices are manipulated by the users everyday, everywhere, we have explored to what extent we can identify **the emotion a user is explicitly expressing through 2D and 3D gestures**. We conducted a field study that enabled us to identify gesture patterns and descriptors correlated to affective dimensions towards the goal of creating emotionally-aware ubiquitous computing that can be widely deployed [22]. Second, we studied input and output interaction modalities that rely on a **camera-based head tracking**. For output, it is possible to realistically control the viewpoint on a 3D scene (Head-Coupled Perspective, HCP) (Figure 1.2.5). Presented at IHM 2011, this study has been awarded best long research paper and we published a demonstration application, i3D (Glasses-free monocular 3D), on iTunes. Third, at the widget level, we designed a new menu, the **Wavelet menu** (Figure 1.2.5), a concentric hierarchical Marking menu using simple gestures. The Wavelet menu has properties that are specific to mobile devices and interaction (e.g., eye-free interaction) that we experimentally validated [33].

Tools for developing UI on mobile devices: Complementary to interaction techniques, we have developed the **NOMAD Toolkit** that allows the implementation of new forms of interaction techniques for high-end Linux-based phones equipped with a variety of sensors and actuators. These interaction techniques include 3D instrumental gestures [31] combined with 2D and 3D rendering (Figure 1.2.5). Beyond a laboratory tool, the toolkit has been used by the industrial partners of the NOMAD project.

Figure 16: Camera-based head tracking: i3D application on iTunes.

Figure 17: Wavelet menu.

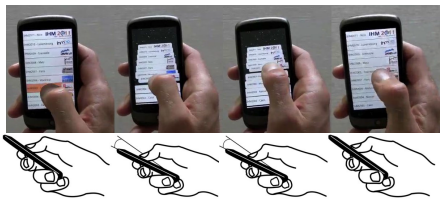

Figure 18: TouchOver technique developed with the NOMAD toolkit.

Participants: F. Bérard, R. Blanch, J. Coutaz, C. Coutrix, M. Ortega, L. Nigay **Doctoral students:** S. Pelurson, E. Rousset, T. Vincent **Thesis defended:** G. Bailly, A. Scoditti, M. Serrano **Video demonstrations:** HCP, Nomad toolkit, TouchOver, Wavelet

1.2.6 Highlights: Publications and Software

During the reporting period, IIHM has published more than **150 articles**, including 63 articles in international conferences, 33 in national conferences, 22 articles in national and international journals as well as 16 chapters in books. In the very dynamic and relatively recent domain of HCI, we stress the fact that it is more prestigious to publish in highly selective international conferences (e.g. ACM-CHI, IEEE-ISMAR or ACM-UBICOMP) than in journals, due to their visibility and level of competition. In this report we only cited the **41 long A/A+ rated publications**. This constitutes a doubling of the number of long papers in conferences and journals rated A/A+, with respect to the previous reporting period:

- 35 International Conferences: **A+**: Articles at CHI (4), ISMAR (1) and UBICOMP (1). **A**: Long articles at AVI (3), BCS-HCI (1), EICS (5), ICMI (4), INTERACT (7), ITS (4), IUI (1), MOBILEHCI (1), Neural Engineering (1), SCC (1), 3DUI (1)
- 6 A-rated international journals: Information and Software Technology – Elsevier (2), Engineering Applications of Artificial Intelligence – Elsevier (1), Expert Systems with Applications – Elsevier

(1), Systems and Software – Elsevier (1), Systems and Software – Elsevier (1), Transactions on Computational Intelligence and AI in Games (T-CIAIG) – IEEE (1).

- We also published 13 short papers in conferences rated A/A+ including CHI (2), EICS (7), INTERACT (2), IUI (1), NordiCHI (1).

We are particularly proud of the **ITEA standardization award** received by the UsiXML project and the **best research long paper** distinction awarded to the three following articles: (1) Using the User's Point of View for Interaction on Mobile Devices. IHM 2011. J. Francone and L. Nigay. (2) Precise pointing techniques for handheld Augmented Reality. INTERACT 2013. T. Vincent, L. Nigay and T. Kurata. (3) Handheld Augmented Reality: Effect of registration jitter on cursor-based pointing techniques. IHM 2013. T. Vincent, L. Nigay and T. Kurata.

Proving the maturity of some produced software applications and tools beyond lab prototypes, IIHM has disseminated **several software tools and applications that are used inside and outside the group** including:

- The E-COMM editor (Multimodal, Multi-User task-oriented specification notation) has been used by BERTIN Technology for specifying command posts and every year since 2011 by software engineering masters students as part of the CSCW course.
- FlexiLab, an extensible model-driven software framework for plastic interfaces is currently in the phase of industrial maturation: several industrial partners declared their interest in the tool including Thalès France, ATOS Origin and BPM-ATC.
- The NOMAD toolkit for implementing new forms of interaction techniques on mobile devices has been used by industrial partners including Myriad Group and ST-Ericsson. In particular an application developed by Myriad Group has been demonstrated by ST-Ericsson at CES (Consumer Electronics Show) 2012 in Las Vegas.
- The Wavelet menu [33] has been integrated into a healthcare information application of a company with a business incubator.
- I3D Itunes application: Head Tracking for iPhone - Glasses-Free 3D Display. I3D has been downloaded more than 1,5 million times. The corresponding video on YouTube has been viewed more than 2 million times (with various articles about it in Wired 2011, MacStories 2011, etc.)

1.3 Visibility and attractivity

Honors:

- National Order of the Legion of Honour: J. Coutaz, March 2013
- IFIP TC13 Pioneer 2013 award: J. Coutaz, Ceremony at Interact 2013, Cape Town
- Institut Universitaire de France: L. Nigay junior member until august 2009
- Promotion class exceptional: L. Nigay 2013
- Humboldt Research Fellowship for postdoctoral researchers: G. Bailly 2011
- Best research long paper distinction awards: 3 articles

Principal local, national and international collaborations: 8 groups of LIG (ADELE, AMA, CONVECS,GETALP, HADAS, MAGMA, PRIMA, SIGMA), **5 laboratories in Grenoble** (GIPSA, G-SCOP, LJK, iRTSV-BGE and TIMC) and **4 laboratories in France** (IRIT, ENSADLab, ESTIA and Telecom Paris-Tech). Our main international collaborations with academic exchanges include: AIST-Tsukuba-Japan, Ecole Supérieure de Technologie-Canada (M. McGuffin), McGill University-Canada (J. R. Cooperstock), Universidad de la República Montevideo-Uruguay, University of Glasgow-UK, University of Rostock-Germany and York University-Canada (W. Stuerzlinger).

Participation to Conferences/Scientific Events and Editorial Committees: IIHM members chaired or participated in 24 program committees of international conferences (AVI, CHI, EICS, IUI, UbiComp, INTERACT, etc.) and 13 program committees of national conferences. IIHM organized IHM 2009 in Grenoble, 20 years after its creation. We are members of the editorial boards of 5 journals including Multimodal Interfaces-Springer, HCI Series-Springer, JIPS and TSI. Finally IIHM members gave 22 keynote addresses and invited lectures during conferences and scientific events.

Management Positions in Scientific Organisations: IIHM is fully involved in the local community: Deputy Director of LIG, elected member of LIG committee and LIG human-resources committee, "Digital Society" program officer for Grenoble INP, Scientific Council of Maison Sciences Humaines - MSH-Alpes, (Univ. Grenoble-Alpes), co-chair of one of the four research axes of Labex Persyval-Lab, assistant director of the EquipEx AmiQual4Home. At the national level, the group is deeply involved in the AFIHM association, the SIF association (scientific committee), and INRIA evaluation committee "Commission d'Evaluation". At the international level, the group is involved in the IFIP WG2.7-13.4-Engineering HCI (general secretary, vice-chairs).

Scientific committees and Steering Committees: IIHM has been intensively involved in scientific and steering committees at the national level including: ALLISTENE (the Digital Sciences and Technologies Alliance, chair of one of 6 national groups), ANR (steering committees), CNRS INS2I scientific committee, DGRI/MESR "Groupe de Concertation Thématique" (Ambient Intelligence), GDR I3 (steering committtee), and National Research Strategy Agenda – France Europe 2020 (evolution of national research startegy, co-writer of one of two scientific priorities-2014).

Evaluation of Research:

- **Research projects: ANR** President of the reviewing committee "Contenus, Connaissances, Interactions" 2014, Member of the reviewing committee: Programme Blanc et Jeunes Chercheuses/Jeunes Chercheurs 2010-12. **ERC** (European Research Council) Member of the evaluation panel for Advanced grants, 2012 and 2014. **FP7 ICT** (European projects) Expert for FP7 ICT calls 8, 10 and Marie-Curie. **Swiss National Science Foundation** reviewer 2009.
- **Laboratories: AERES** (National Evaluation Agency) Member of the Visiting committee for LRI (2009 and 2013) and labSTICC (2010)
- **Hiring committees:** IIHM - member of 12 hiring committees in France.
- **Habilitation and PhD committees**: IIHM group members: president, reviewer or examiner of 57 PhD committees and 8 Habilitation committees.

1.4 Social, economical, and cultural impact

HCI has an impact on nearly every social, economic and cultural domain where informatics is used. The potential for innovation is high, as illustrated by our i3D Itunes demonstrator, downloaded 1,5 million times. The diversity of applications and research potential is a firm driving force for the group to strive for generality. Also, attentive to addressing more applied challenges, the group has conducted numerous pluridisciplinary and industrial collaborative projects. Such collaborative projects enable us to evaluate our developed techniques in the field and to apply our methods on large industrial projects.

1.4.1 Social and Economic Impact: National and International Collaborative Projects

Pluridisciplinary studies with social or economic impact have been conducted with Humanities and Social Sciences laboratories of the Federative Research Structure INNOVACS: user experience of technological artifacts, equipex Amiqual4Home for smart homes, classroom of the future. As part of a CNRS project of the INS2I pluridisciplinary department on large-scale scientific data (MASTODONS 2012 call), we are studying interactive visualization for bioinformatics analysis (proteomics data sets).

We have implemented our methods and interaction techniques for application domains and scenarios defined by our **industrial partners** (e.g., AIRBUS, Aesculap – Bbraun, Bertin technology, EDF,

Motwin, Myriad group, Orange labs, SAGEM, Schneider Electric, STmicroelecronics, Thales, ViTechnology). **Novel interaction techniques** have been applied in various settings and application domains (1) interactive visualization for desktops, table-tops, and handheld devices (2) 3D interaction for visual inspection of electronic boards and for design and architecture (3) distant pointing techniques for augmented surgery. **For multimodal interaction**, our typical application domains include: games, military and civil aircraft cockpits, command post for controlling drones. **UI plasticity** has been tested with web-based services such as administrative services for the citizen, on the case study of continuity of services for water professionals, in the domain of Health Care IT and with case studies from the nuclear power plant domain. End-user programming solutions are applied to the domain of smart homes. **Mixed Reality interaction** has been applied to mobile games/guided tours, dance performance, teaching anatomy, smart buildings (hotel and restaurant), and maintenance in production plants. **Mobile interaction** has been applied to touristic tours, to the navigation within large information spaces, to healthcare information application and to maintenance in production plants.

The following table summarizes the contracts and grants of IIHM during the reporting period.

source of funding	project acronym (in bold, ongoing projects)	funding for IIHM
European projects	OI (FP6, STREP Coord.), MOSAIC (regional program ICT-Asia), UsiXML (ITEA2), **AppsGate** (CATRENE), **Leonardo da Vinci** (Education)	1 552 536
ANR	MyCitizSpace (TLOG), CONTINUUM (VERSO), CARE (Audiovisuel et Multimédia), **SYSEO** (TecSan), **AMIE** (Blanc Int., Coord.)	661 335
Investment for the Future "Investissement d'avenir"	**CONNEXION** (BGLE), **AMIQUAL4HOME** (EquipEx), **TAPIOCA** (LabEx PERSYVAL-Lab), **LBA** (LabEx PERSYVAL-Lab), **Pointage** (Labex PERSYVAL-Lab)	294 935
FUI	NOMAD, BIMSITE, **DELIGHT**, **3DCI**	1 309 263
French Defense Agency	Partage d'Autorité (PEA), **FENICS** (AERO)	98 088 (+ grant for 2 Ph.D. students)
Contracts with Industry	**Orange Labs**, **MotWin**, **Aesculap**, CORYS	191 918
Internal Funding	K-IHM (MSTIC), IUF, SYMCURE (start-up), **INTUACTIVE** (BQR), TrackingHead (LSI CARNOT), CAICO (BQR), **TIGRE** (MSTIC), **FlexiLab** (GRAVIT)	189 810
	Total funding (euros)	**3 636 550**

Instead of describing each project (see <iihm.imag.fr>), we highlight two domains: (1) **smart building** which is within one of the three leading initiatives of LIG with a strong societal impact, (2) **factory** for which our studies are fully aligned with the Sept. 2013 national strategic plan "Nouvelle France industrielle" and in particular with 2 out of the 34 priorities "Augmented Reality" and "Future Factory".

Four on-going projects are dedicated to smart buildings: Dedicated to ambient intelligence, the equipex Amiqual4Home provides IIHM with a platform to build experiments and perform in-field experiments in apartments. With the goal to develop the "set-top-box of the future", IIHM as a partner of AppsGate, explores End-User Development solutions. Our designed solutions will be tested in real-world contexts with volunteer families in their own home. Complementary to this study on EUD, we also focus on interaction techniques for the direct control of the smart environments: (1) In collaboration with GETALP-LIG, we study speech commands mediated by a robot to control a smart environment. (2) As part of the FUI DELIGHT, we have designed physical interaction techniques to control light sources controlled by an integrated lighting infrastructure based on a LED-box. The interaction techniques will be tested in hotel rooms and restaurants.

Dedicated to innovative factories, IIHM is part of three on-going projects. In the CONNEXION project (Investissement d'avenir) dedicated to nuclear power plants, we are focusing on UI plasticity by promoting model-driven engineering for the development of UI. CONNEXION provides a real case study on a large system (i.e. nuclear plant control command) for UI plasticity that goes beyond simple academic demonstration. In the FUI 3DCI (3D Component Inspection), the application domain is the inspection machine in production plants of electronic boards. This project provides IIHM with a real-world context to study 3D interaction techniques that will be tested with operators. Finally, in the

AMIE project (ANR "Blanc" international project, IIHM coordinator), the application domain is the maintenance operations in production plants: Our handheld Augmented Reality techniques have been tested experimentally for maintenance operations in a Schneider production plant.

1.4.2 Cultural Impact

IIHM has been involved in **three cultural public performances**.

The **CARE show** in March 2011 at the Casino de Biarritz ended the CARE project (ANR project on Cultural Experience: Augmented Reality and Emotion). In close collaboration with the Malandain Ballet of Biarritz, we have demonstrated an **augmented dance show** (movement-based emotion recognition of the dancer as an input modality for augmenting the stage). <iihm.imag.fr/contract/care/>

Ilumina is an **interactive installation** developed in collaboration with Tomás Laurenzo, an artist and researcher at Universidad de la República in Montevideo (Uruguay). The installation consists of a space with irregular pyramids in it. The installation detects when a person is in the room and creates the illusion of this person emitting light. <iihm.imag.fr/blanch/projects/ilumina/>

The **Common Touch installation** is a large interactive wall that interacts with passers-by through touch and affective modalities. At this occasion, the interaction has been studied together with Anne Bationo from Orange Labs and Université Paris 8 and Elisa Rubegni from University of Lugano. <iihm.imag.fr/coutrix/art/TheCommonTouch/thecommontouch.html>

1.4.3 Science Popularization and Industrial Events

- June 2009, M. Serrano and C. Coutrix (PhD students) co-organized PLAY-IN, the first edition of a local pluridisciplinary event on interactive urban environment in Grenoble.
- March 2009, "Vendredi de l'innovation" ST Ericsson: invited talk by R. Blanch on HCI.
- March 2010, Exhibit stands. CeBIT 2010, STIC, Hannover, Germany. Multi-touch interaction.
- October 2010, National Science days (La fête de la Science) organized by CNRS. Demonstration stand: Exploring a map with a cubtile.
- March 2011, CARE augmented dance show at the Casino de Biarritz.
- May and June 2011, interactive installation Common Touch demonstrated at École Nationale des Arts Décoratifs in Paris.
- Sept. 2011, interactive installation Ilumina demonstrated at the PLAY-IN festival in the streets of Grenoble.
- October 2013, National Science days (La fête de la Science) organized by CNRS. Experimenta, a 3-day exhibit. In collaboration with the Prima and Adele research groups, presentation of the 1rst prototype of the AppsGate Smart Home end-user development where 200 visitors have been able to develop and run simple programs for defining the behavior of a reproduced home.
- December 2013, 1 day exhibit of the AppsGate prototype (collaboration with the Prima and Adele research groups) at the EIT ICTlabs Health&WellBeing end-of-year event. This forum, organized by the EU ICTLabs, had 250 attendees, mostly startups and SMEs. (EIT ICT Labs is one of the first Knowledge and Innovation Communities set up by the European Institute of Innovation and Technology, as an initiative of the European Union.)
- Since 2011, L. Nigay as part of the scientific committee the French Association for Computer Science (SIF: Société Informatique de France) participates to the promotion of computer science (definition "l'informatique: la science au coeur du numérique" 1024 SIF newsletter, brief history of informatics).
- Since January 2012, C. Coutrix is editor-in-chief of Lili, the magazine of Grenoble Informatics Laboratory (lili.liglab.fr).

1.5 Team Organization and life

With regards to the everyday life of the group and to better manage the larger size of the group, we organize three meetings per month (called "lunch équipe") in addition to meetings between permanent

faculty members (lunch). The **three group meetings per month** take different forms: meeting with presentations by visitors, masters/doctoral students and permanent members on a specific topic, meeting to demonstrate a tool and at least once a month a writing workshop where we all comment on abstracts/articles being written. Moreover articles are exchanged and commented by the group members (if enough time before the deadline).

In addition to bringing the 3D expertise to the group, the arrival of M. Ortega as **a part-time CNRS engineer** (Wednesday midday to Friday in the team) significantly contributes to a better management of the software produced by the group. First, he **accentuates and solidifies our technical know-how**: In particular he maintains a complete set of tools/demonstrations (**IIHM showcase**) (including demonstrations of past doctoral students) in our playground experimental set-up that he fully re-installed. This is a very important contribution to the group since we welcome several (academic and industrial) visitors and we can display a comprehensive IIHM showcase along with the scientific discourse. Second, he develops and maintains the playground platform that integrates several interaction devices (stereoscopic screen, movement sensors, tactile devices) by providing a communication middleware based on the OSC protocol. He also provides precious support to members (in particular masters and doctoral students) for using the devices of the playground. This support is crucial to efficiently use the interaction devices of the platform. Our choice was not to develop a common software framework (e.g., a common toolkit or UIDE) for the group that will constraint the research to a platform that may become obsolete in a very dynamic domain: our goal is to facilitate the reuse of devices, interaction techniques and experiences from our research projects with the playground platform. The contribution of M. Ortega to several on-going projects is precious and we can only regret that he is presently in the team only 2 days and a half per week.

The governance of the team is based on the principles of the "reasonable person", on scientific mutual respect and freedom, and encourages initiatives and hard work. The contribution and collaboration between the group members on different themes guarantees a strong scientific consistency of the IIHM group in covering significant issues in HCI. Every new permanent team member gets the financial support from the team that is necessary to start a new theme as well as new contracts (travel, students gratification, equipment). Every student is enrolled within a research contract and is offered to attend reference conferences in the field (even if no publication) to get acquainted with the mechanisms of research.

1.6 Training through research, educational involvment

1.6.1 Doctoral Students

16 students defended their PhD thesis successfully during the reporting period. The average duration was 44 months. 5 of the past doctoral students have a permanent academic position in France (lecturers or CNRS researchers) and Luxembourg, 2 of them are currently post-docs abroad, while 8 of them are working in private companies.

1.6.2 Supervision of Educational Programs

9 out of 11 members of the group are full teachers at IUT, university and engineer school programs. So these members must devote "continuous partial attention" to teaching, administration, and research. They all teach on average 192 hours per year and are responsible for courses in HCI. Moreover the group members are also involved in the supervision of different educational programs:

- S. Dupuy-Chessa and Yann Laurillau are fully involved in the Informatics Department of IUT2 and take important responsibilities including director of studies and project management. Franck Tarpin-Bernard has been director of the department SRC of IUT1 from 2012 to 2013.
- Since 2006, F. Bérard has been responsible for international student exchange program for Ensimag.
- L. Nigay is in charge of Professional Master's program in Software Engineering (M2P-GI, 39 students this year) since 2005. She has also created a new Software Engineering Masters Apprenticeship Program (12 students this year). Since 2006, she is responsible of a complete module on multimodal interaction at the University of Eindhoven (TU/e).

IIHM (in collaboration with the METAH-LIG group) is involved in a European teaching project Leonardo da Vinci (now called Erasmus+) where we build a coherent set of courses on usability and

name	first reg.	defense	dur.	Univ.	supervisor	current position	funding
V. Ganneau	Oct. 05	Jan 09	40	UJF	G. Calvary 50% R. Demumieux (Orange Labs) 50%	Engineer, Haploid company (Paris)	Orange Labs
G. Bailly	Oct. 05	May 09	44	UJF	L. Nigay 50% E. Lecolinet (Telecom Paris-Tech) 50%	CR2 CNRS, Telecom Paris-Tech	MESR
C. Coutrix	Oct. 05	May 09	44	UJF	L. Nigay	CR2 CNRS, LIG-IIHM	MESR
G. Godet-Bar	Oct. 06	Nov. 09	38	INPG	S. Dupuy-Chessa 50% D. Rieu (SIGMA) 50%	Research engineer, Magilem company (Paris)	MESR
G. Gauffre	Oct. 05	Dec. 09	51	Toulouse 1	L. Nigay 25% E. Dubois (Toulouse) 55% R. Bastide (Toulouse) 20%	Unknown	Projects Toulouse
A. Clay	Oct. 06	Dec. 09	39	Bordeaux 1	L. Nigay 30% N. Couture (Estia) 60% M. Delest (Bordeaux 1) 10%	Lecturer, School ESTIA	ESTIA
J. Perez-Medina	Oct. 06	June 10	45	Grenoble	S. Dupuy-Chessa 50% D. Rieu (SIGMA) 50%	Engineer, EURA NOVA company, Belgium	Venezuela
M. Serrano	Oct. 07	June 10	33	Grenoble	L. Nigay	Lecturer, Toulouse III	FP6
F. Jourde	Nov. 07	June 11	44	Grenoble	Y. Laurillau 50% L. Nigay 50%	Project manager, Extellient company (Grenoble)	DGA
A Scoditti	Feb. 08	Sept.11	44	Grenoble	J. Coutaz 50% R. Blanch 50%	Software Engineer, Intel Mobile Communications (Sophia)	FUI
Y. Gabillon	Sept. 07	Oct.11	50	Grenoble	G. Calvary 50% H. Fiorino (MAGMA) 50%	Research fellow, Centre de Recherche Public Gabriel Lippmann, Luxembourg	Rhônes-Alpes region
F. Camara	Nov. 08	Sept. 12	47	Grenoble	G. Calvary 50% R. Demumieux (Orange Labs) 50%	Engineer R&D, Viseo ObjectDirect (Grenoble)	Orange Labs
C. Martin	Oct. 08	Oct. 12	49	Grenoble	G. Calvary 50% H. Fiorino (MAGMA) 50%	Post doc Distributed Artificial Intelligence (DAI) Berlin	MESR
E. Fontaine	Oct. 08	July 12	46	Grenoble	J. Coutaz 50% A. Demeure (PRIMA) 50%	Engineer, Thales Services	ANR
P-A. Avouac	Oct. 08	Feb. 13	53	Grenoble	L. Nigay 50% P. Lalanda (ADELE) 50%	Engineer, Company (Lyon)	Industrial Projects ADELE and IIHM
J. Francone	Oct. 09	Abandonned		Grenoble	L. Nigay 75% R. Blanch 25%	Co-founder of 1Button SARL (Grenoble)	MESR
A. Garcia Frey	Oct. 09	July 13	46	Grenoble	G. Calvary 50% S. Dupuy-Chessa 50%	Post-doc, Centre de Recherche Public Henri Tudor, Luxembourg	ITEA2

accessibility with two partners, the University of Lublin (Poland) and the University of Alicante (Spain). IIHM courses include usability and 3D interaction.

As a joint effort of IIHM, we have created in 2012 **the specialized program "Ubiquitous and Interactive Systems" (30 ECTS)** of the International Masters of Science in Informatics at Grenoble. Managed by R. Blanch and L. Nigay, this specialized program involves 9 members of the group, teaching three new courses on HCI. This group investment was motivated by the fact that HCI was no longer explicitly present at the Master 2 research program and the goal is to attract students (international masters program) and recruit future doctoral students, well trained in HCI.

1.7 Strategy and Research Project

The continued exponential growth in the number of interconnected devices with embedded sensing, actuation, interaction in human environments define a wide and ever-increasing variety of interaction techniques and very diverse settings for human-computer interaction, beyond the desktop. Our scientific project naturally takes place and embraces this current evolution of computer science in response to evolving technology towards ambient intelligence. Fully aligned with the LIG strategic plan, ambient intelligence defines the general framework of our research agenda focusing on expanding graphical user interfaces and on studying new interaction possibilities and interaction contexts. The research challenges that we address in this context are numerous and far-reaching. The five themes that structure the IIHM research agenda are: **1) Novel Interaction Techniques for GUI 2) Multimodal Interaction 3) User Interface Plasticity 4) Mixed Reality Interaction 5) Mobile Interaction**. Our five research themes will be sustained by focusing on specific research lines within a theme and by establishing research lines that span several themes.

Specific research lines within themes: We will continue to deepen our research lines for each of our themes. We give examples of research lines that illustrate research problems that we address at different levels of abstraction or granularity.

At the device and interaction technique level, we will continue to create novel GUI-based interaction techniques to improve efficiency, comfort, and pleasure for generic HCI tasks including multi-touch direct and indirect interaction and distant interaction. Moreover, our recent research lines on brain/muscle-computer interaction will be pursued. We envision fostering research on muscle-computer interaction as a means to support multiuser interaction and computer-supported cooperative work activities, such as capturing gesture intentions to better support mediated human-to-human communication.

At the user interface level, information visualization is one research theme we will reinforce. There is a need to better understand how to build highly effective interactive visualizations, so that the challenges raised by a new order of magnitude in the size of the data (aka Big Data) can be tackled by combinations of algorithms and human analysis. We have already started to address this by collaborating with teams specialized in data mining.

At the system level, with regard to UI plasticity, we will address two new research questions respectively related to the abstraction and presentation of plasticity: first, is it possible to make progress in UI plasticity by considering knowledge in neurosciences? Secondly, how to guide the end-user during the UI adaptation? For task modelling, we will study the effectiveness of links between task models and other models/artefacts used during the development process of interactive systems, such as scenarios based on captured usage data. For end-user development, we will address two key challenges in the context of smart homes: to support end-users with tools for debugging and reuse.

Research lines spanning over several themes: As described in the section "Scientific and Technological Results", several research axes encompass several themes.

Within the themes "User Interface Plasticity", "Mobile Interaction" and "Mixed Reality Interaction", the group will further develop the research area of deformable mixed physical-digital objects, whose interactional capabilities and physical shape can adapt to the user's will. Leveraging recent advances in hardware and physics, the aim is to provide users with shape-changing Tangible User Interfaces to dynamically adapt the interaction. There is a need for theories, prototypes and user studies, as well as tools for the development of these new interfaces. Notably, deformable devices are now emerging on the market and nanotechnology companies are growing, including in local industry.

Another research area we will study is Spatial Augmented Reality (SAR) where digital content is directly projected onto physical objects. The main research challenges of SAR systems have been centred on the display part to ensure an effective mapping between the real and the digital worlds. In this context of SAR, we adopt a complementary approach by focusing on interaction with augmented physical objects. This research area encompasses "Novel Interaction Techniques" and in particular 3D and touch interaction, as well as "Mixed Reality Interaction" by exploring other types of Augmented Reality (AR) systems that do not require a display in contrast to see-through AR (e.g., handheld AR).

With regard to **our research approach**, combining conceptual and empirical studies, we plan further experimental field studies. In the application domain of smart homes, we will conduct **in-field studies** of (1) End-User Development solutions for providing inhabitants with the appropriate tools to shape the behaviour of their home in accordance to their needs; (2) physical interaction techniques to control LED lights in the context of a hotel room and a restaurant. For distant pointing techniques, we have initiated inclusion of our distant pointing techniques in an orthopaedic surgery application in order to conduct field-studies with surgeons.

One important issue when defining the research agenda of a group is to identify a structure that coherently covers significant issues for the future of HCI and encourages collaboration and capitalization of research studies, while **allowing each member to develop her/his research program within an appropriate and specific research topic of their interest**. Our five-themes structure facilitates this. **Each member of IIHM develops her/his scientific lead** in a research topic that can also traverse several of the five themes: F. Bérard multi-touch interaction, R. Blanch visualization and pointing techniques, S. Caffiau task analysis, G. Calvary plasticity, J. Coutaz end-user development, C. Coutrix mixed physical-digital objects, S. Dupuy-Chessa development method and process, Y. Laurillau CSCW, L. Nigay multimodality, M. Ortega 3D interaction, F. Tarpin-Bernard brain-computer interaction.

1.8 Self assesment

1.8.1 Strengths

IIHM is a dynamic, highly visible research group that is actively engaged in both the national and international scientific communities devoted to Human-Computer Interaction (HCI). IIHM has a high academic recognition in HCI, which is reflected by the participation in numerous program committees of national and international conferences and by a strong publication record. Our results are published in the major international conferences of the domain which is the key vector for presenting and promoting

HCI contributions. For the reporting period, we have published in the major general HCI conferences including CHI, INTERACT and AVI, as well as in the key conferences corresponding to specific domains of HCI and in direct relation with our main research themes: ITS, 3DUI, ICMI, EICS, ISMAR and MobileHCI. This also confirms the visibility of our research in each theme.

Two strengths specific to IIHM are (1) its ability to conduct both analytical and empirical research studies and to fruitfully combine them, and (2) its unique capability to address research problems at different levels of abstraction and granularity leading to contributions ranging from the entire interactive system level to a particular interaction device or sensory-motor phenomenon level.

As demonstrated by our numerous projects as well as by the innovative nature of the conducted research in each theme including new successful research axes and teaching activities in HCI, the group is particularly opened to novel ideas and to stimulating collaborations with both the academic community and the industry. We are convinced that novelty and progress emerge by bringing together multiple sources of knowledge, while maintaining a good balance between concepts and experiments by fruitfully combining analytical and empirical studies. As an integral part of the culture of the group, we establish collaborations, when relevant for a given problem, with other specialties in Computer Science. The numerous collaborations of IIHM with different LIG teams and other labs reflect this. Complementary to fertile academic collaborations, the group is also attentive to the requirements of industry, which provides our research agenda with hard, real world problems, and enables IIHM to conduct in-field experimental evaluations. The numerous projects conducted with industrial partners confirm this. Another important strength is the attractiveness and dynamicity of the group inherent in welcoming visiting scientists and doctoral students. During the reporting period, sixteen students have defended their PhD thesis successfully. Eight of them are working in industry, and five of them have permanent academic positions as full researchers (two CNRS and one in Luxembourg) and lecturers (Toulouse and ESTIA). The dissemination of our former PhD students increases the visibility of the group and contributes to developing our close network of academic and industrial collaborations. Finally, we highlight that we enjoy the liberty of research, the flexible collaborative style of research and the vividness of our group.

1.8.2 Weaknesses

IIHM has only one full-time researcher and a part-time engineer, who joined us during the reporting period. These two new members in the group are key contributors to advancing our research. With the exception of J. Coutaz who is now Professor Emeritus, the other eight permanent members are faculty members who are permanently switching activity between teaching, research and administration. The faculty members are deeply involved in teaching and take teaching responsibilities that are important and challenging but obviously time-consuming. Moreover, the faculty members are intensely involved in the local (LIG lab direction, Labex axis responsibility, Grenoble INP scientific mission), national (ALLISTENE, CNRS, INRIA, National Strategy) and European committees (ERC, FP7): While this demonstrates the increasing visibility of the HCI domain, these activities related to research management and animation are very time-consuming reducing the advance of our own research. In order to reinforce the research capability of the group, we have to intensify our efforts to recruit junior researchers.

1.8.3 Threats

Two different threats are identified. First while industrial projects provide real-world problems and enable us to evaluate our developed techniques in the field and to apply our methods on real large projects, they are also time-consuming (deliverables, management, hiring time). The various solicitations from industrial partners that now recognize that the user interface is a differentiator for their business and the fact that very few students receive Ministers research fellowships for their PhD, leads to a large number of industrial collaborative projects in very diverse application domains (currently 3 CIFRE doctoral students and 2 Orange-Labs doctoral students). We have created the research masters specialty in order to recruit well-trained PhD students, hopefully with a Ministers research fellowship. Moreover to attain a right balance between industrial and research projects, while maintaining a strong link with industrial partners, we must increase the number of research projects (ANR 'blanc', JCJC and ERC). A second threat of a completely different nature is related to the composition of the team with five lecturers. We can anticipate that in the coming period several of them will be habilitated (one being already habilitated). With a local context with very few available local positions and many already

habilitated candidates, we anticipate that some members may take positions in other Universities. This may necessitate reorganization of the research themes of the group.

1.8.4 Opportunities

Interactive systems are ubiquitous: the continuous integration of informatics into all aspects of human society and the ever-increasing number of innovative interactive technologies provide new opportunities for users while defining challenges for the design, development and evaluation of the corresponding interactive systems. HCI thus gains visibility in both the academic and industrial worlds. This provides a great opportunity for IIHM to advance its group research. The numerous collaborations with LIG teams and other local laboratories as well as our involvement in the labex Persyval, the EquipEx AmiQual4Home, and the SFR INNOVACS (Humanities and Social Sciences lab) providing additional opportunities for pluridisciplinary collaborations, demonstrate the great local context for pursuing our research agenda, fully aligned with the European and national research strategies.