Activity Report 2018

Team LOKI

technology and knowledge for interaction

Inria teams are typically groups of researchers working on the definition of a common project, and objectives, with the goal to arrive at the creation of a project-team. Such project-teams may include other partners (universities or research institutions).

RESEARCH CENTER
Lille - Nord Europe

THEME
Interaction and visualization

Table of contents

Team LOKI

Creation of the Team: 2018 January 01

Keywords:

Computer Science and Digital Science:

A5.1. - Human-Computer Interaction
A5.1.1. - Engineering of interactive systems
A5.1.2. - Evaluation of interactive systems
A5.1.3. - Haptic interfaces
A5.1.4. - Brain-computer interfaces, physiological computing
A5.1.5. - Body-based interfaces
A5.1.8. - 3D User Interfaces
A5.1.9. - User and perceptual studies
A5.2. - Data visualization
A5.6.1. - Virtual reality
A5.6.4. - Multisensory feedback and interfaces
A5.7.2. - Music

Other Research Topics and Application Domains:

B2.2.6. - Neurodegenerative diseases
B2.8. - Sports, performance, motor skills
B6.1.1. - Software engineering
B9.2.1. - Music, sound
B9.5.1. - Computer science
B9.5.6. - Data science
B9.6.10. - Digital humanities
B9.8. - Reproducibility

1. Team, Visitors, External Collaborators

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Thomas Pietrzak [Université de Lille, Associate Professor]

Post-Doctoral Fellow

Raiza Sarkis Hanada [Inria, from Dec 2018]

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Amira Chalbi [Inria, until Mar 2018]

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Damien Masson [Inria, from Oct 2018]

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Administrative Assistants

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2. Overall Objectives

2.1. Introduction

Human-Computer Interaction (HCI) is a constantly moving field [38]. Changes in computing technologies extend their possible uses and modify the conditions of existing ones. People also adapt to new technologies and adapt them to their own needs [42]. Different problems and opportunities thus regularly appear that require to be addressed from both the user and the machine perspective, in order to understand and account for the tight coupling between human factors and interactive technologies. Our vision is then to link together these two essential elements: *Knowledge & Technology for Interaction*.

2.2. Knowledge for Interaction

In the early 1960s, at a time where computers were scarce, expensive, bulky and formal-scheduled machines used for automatic computations, ENGELBART saw their potential as personal interactive resources. He saw them as *tools* we would purposefully use to carry out particular tasks and that would empower people by supporting intelligent use [35]. Others at the same time were seeing computers differently, as *partners*, intelligent entities to whom we would delegate tasks. These two visions still constitute the roots of today's predominant HCI paradigms, *use* and *delegation*. In the delegation approach, a lot of effort has been made to support oral, written and non-verbal forms of human-computer communication, and to analyze and predict human behavior. But the inconsistency and ambiguity of human beings, and the variety and complexity of contexts, make these tasks very difficult [46] and the machine is thus the center of interest.

2.2.1. Computers as tools

Our focus is not in what machines can understand or do by themselves, but in what people can do with them. We do not reject the delegation paradigm but clearly favor the one of tool use, aiming for systems that support intelligent use rather than intelligent systems. And as the frontier between the two is getting thinner, **one of our goals is to better understand what it takes for an interactive system to be perceived as a tool or a partner, and how the two paradigms can be combined for the best benefit of the user.**

2.2.2. Empowering tools

The ability provided by interactive tools to create and control complex transformations in real-time can support intellectual and creative processes in unusual but powerful ways. But mastering powerful tools is not simple and immediate, it requires learning and practice. **Our research in HCI should not just focus on novice or highly proficient users but should also care about intermediate ones willing to devote time and effort to develop new skills, whether for work or leisure.**

2.2.3. *Transparent tools*

Technology is most empowering when it is transparent: invisible in effect, it does not get into your way but lets you focus on the task. HEIDEGGER characterized this unobtruded relation to things with the term *zuhanden* (*ready-to-hand*). Transparency of interaction is not best achieved with tools mimicking human capabilities, but with those taking full advantage of them given the context and task. For instance, the transparency of driving a car "*is not achieved by having a car communicate like a person, but by providing the right coupling between the driver and action in the relevant domain (motion down the road)*" [49]. Our actions towards the digital world need to be digitized and we must receive proper feedback in return. But input and output technologies pose somewhat inevitable constraints while the number, diversity, and dynamicity of digital objects call for more and more sophisticated perception-action couplings for increasingly complex tasks. **We want to study the means currently available for perception and action in the digital world: Do they leverage our perceptual and control skills? Do they support the right level of coupling for transparent use? Can we improve them or design more suitable ones?**

2.3. Technology for Interaction

Studying the *interactive phenomena* described above is one of the pillars of HCI research, in order to understand, model and ultimately improve them. Yet, we have to make those phenomena happen, to make them possible and reproducible, whether it be for further research or for their diffusion [37]. However, because of the high viscosity and the lack of openness of actual systems, this requires considerable efforts in designing, engineering, implementing and hacking hardware and software interactive artifacts. This is what we call "*The Iceberg of HCI Research*", of which the hidden part supports the design and study of new artifacts, but also informs their creation process.

2.3.1. *"Designeering Interaction"*

Both parts of this iceberg are strongly influencing each other: The design of interaction techniques informs on the capabilities and limitations of the platform and the software being used, giving insights into what could be done to improve them. On the other hand, new architectures and software tools open the way to new designs, by giving the necessary bricks to build with [39]. These bricks define the adjacent possible of interactive technology, the set of what could be designed by assembling the parts in new ways. Exploring ideas that lie outside of the adjacent possible require the necessary technological evolutions to be addressed first. This is a slow and gradual but uncertain process, which helps to explore and fill a number of gaps in our research field but can also lead to deadlocks. **We want to better understand and master this process –i. e., analyzing the adjacent possible of HCI technology and methods– and introduce tools to support and extend it. This could help to make technology better suited to the exploration of fundamentals of interaction and to their integration into real systems, a way to ultimately improve interactive systems to be empowering tools.**

2.3.2. *Computers vs Interactive Systems*

In fact, today's interactive systems –e. g., desktop computers, mobile devices– share very similar layered architectures inherited from the first personal computers of the 1970s. This abstraction of resources provides developers with standard components (UI widgets) and high-level input events (mouse and keyboard) that obviously ease the development of common user interfaces for predictable and well-defined tasks and users' behaviors. But it does not favor the implementation of non standard interaction techniques that could be better adapted to more particular contexts, to expressive and creative uses. It often requires to go deeper into the system layers and to hack them until getting access to the required functionalities and/or data, which implies switching between programming paradigms and/or languages.

And these limitations are even more pervading as interactive systems have changed deeply in the last 20 years. They are no longer limited to a simple desktop or laptop computer with a display, a keyboard and a mouse. They are becoming more and more distributed and pervasive (e. g., mobile devices, Internet of Things). They are changing dynamically with recombinations of hardware and software (e. g., transition between multiple devices, modular interactive platforms for collaborative use). Systems are moving “out of the box” with Augmented Reality, and users are going “ inside of the box” with Virtual Reality. This is obviously raising new challenges in terms of human factors, usability and design, but it also deeply questions actual architectures.

2.3.3. The Interaction Machine

We believe that promoting digital devices to **empowering tools** requires **better fundamental knowledge about interaction phenomena** AND to **revisit the architecture of interactive systems** in order to support this knowledge. By following a comprehensive systems approach –encompassing human factors, hardware elements and all software layers above– we want to define the founding principles of an *Interaction Machine*:

- a set of hardware and software requirements with associated specifications for interactive systems to be tailored to interaction by leveraging human skills;
- one or several implementations to demonstrate and validate the concept and the specifications in multiple contexts;
- guidelines and tools for designing and implementing interactive systems, based on these specifications and implementations.

To reach this goal, we will adopt an opportunistic and iterative strategy guided by the *designeering* approach, where the engineering part will be fueled by the interaction design and study part. We will address several fundamental problems of interaction related to our vision of “empowering tools”, which, in combination with state-of-the-art solutions, will instruct us on the requirements for the solutions to be supported in an interactive system. This consists in reifying the concept of the Interaction Machine in multiple contexts and for multiple problems, before to converge towards a more unified definition of “what is an interactive system”, the ultimate Interaction Machine, which makes the main scientific and engineering challenge of our project.

3. Research Program

3.1. Introduction

Interaction is by nature a dynamic phenomenon that takes place between interactive systems and their users. Redesigning interactive systems to better account for interaction requires fine understanding of these dynamics from the user side so as to better handle them from the system side. In fact, layers of actual interactive systems abstract hardware and system resources from a system and programing perspective. Following our Interaction Machine concept, we are reconsidering these architectures from the user perspective, through different *levels of dynamics of interaction* (see Figure 1).

Considering phenomena that occur at each of these levels as well as their relationships will help us to acquire the necessary knowledge (Empowering Tools) and technological bricks (Interaction Machine) to reconcile the way interactive systems are designed and engineered with human abilities. Although our strategy is to investigate issues and address challenges for all of the three levels, our immediate priority is to focus on micro-dynamics since it concerns very fundamental knowledge about interaction and relates to very low-level parts of interactive systems, which is likely to influence our future research and developments at the other levels.

3.2. Micro-Dynamics

Micro-dynamics involve low-level phenomena and human abilities which are related to short time/instantness and to perception-action coupling in interaction, when the user has almost no control or consciousness of the action once it has been started. From a system perspective, it has implications mostly on input and output (I/O) management.

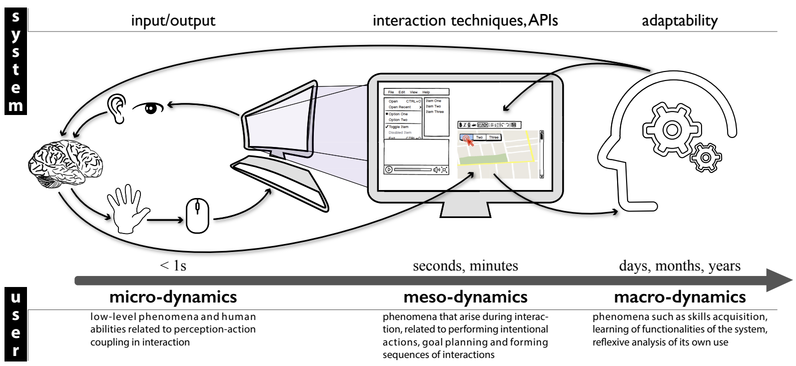

Figure 1. Levels of dynamics of interaction.

3.2.1. Transfer functions design and latency management

We have developed a recognized expertise in the characterization and the design of *transfer functions* [34], [45], i. e., the algorithmic transformations of raw user input for system use. Ideally, transfer functions should match the interaction context. Yet the question of how to maximize one or more criteria in a given context remains an open one, and on-demand adaptation is difficult because transfer functions are usually implemented at the lowest possible level to avoid latency. Latency has indeed long been known as a determinant of human performance in interactive systems [41] and recently regained attention with touch interactions [40]. These two problems require cross examination to improve performance with interactive systems: Latency can be a confounding factor when evaluating the effectiveness of transfer functions, and transfer functions can also include algorithms to compensate for latency.

We have recently proposed new cheap but robust methods for the measurement of end-to-end latency [2] and are currently working on compensation methods and the evaluation of their perceived side effects. Our goal is then to automatically adapt the transfer function to individual users and contexts of use while reducing latency in order to support stable and appropriate control. To achieve this, we will investigate combinations of low-level (embedded) and high-level (application) ways to take user capabilities and task characteristics into account and reduce or compensate for latency in different contexts, e. g., using a mouse or a touchpad, a touch-screen, an optical finger navigation device or a brain-computer interface. From an engineering perspective, this knowledge on low-level human factors will help us to rethink and redesign the I/O loop of interactive systems in order to better account for them and achieve more adapted and adaptable perception-action coupling.

3.2.2. Tactile feedback & haptic perception

We are also concerned with the physicality of human-computer interaction, with a focus on haptic perception and related technologies. For instance, when interacting with virtual objects such as software buttons on a touch surface, the user cannot feel the click sensation like with physical buttons. The tight coupling between how we perceive and how we manipulate objects is then essentially broken although this is instrumental for efficient direct manipulation. We have addressed this issue in multiple contexts by designing, implementing and evaluating novel applications of tactile feedback [5].

In comparison with many other modalities, one difficulty with tactile feedback is its diversity. It groups sensations of forces, vibrations, friction or deformation. Although this is a richness, it also raises usability and technological challenges since each kind of haptic stimulation requires different kinds of actuators with their own parameters and thresholds. And results from one are hardly applicable to others. On a "knowledge" point of view, we want to better understand and empirically classify haptic variables and the kind of information they can represent (continuous, ordinal, nominal), their resolution, and their applicability to various contexts. From the “technology” perspective, we want to develop tools to inform and ease the design of haptic interactions taking best advantage of the different technologies in a consistent and transparent way.

3.3. Meso-Dynamics

Meso-dynamics relate to phenomena that arise during interaction, on a longer but still short time-scale. For users, it is related to performing intentional actions, to goal planning and tools selection, and to forming sequences of interactions based on a known set of rules or instructions. From the system perspective, it relates to how possible actions are exposed to the user and how they have to be executed (i. e., interaction techniques). It also has implication on the tools for designing and implementing those techniques (programming languages and APIs).

3.3.1. Interaction bandwidth and vocabulary

Interactive systems and their applications have an always increasing number of available features and commands due to e. g., the large amount of data to manipulate, increasing power and number of functionalities, multiple contexts of use.

On the input side, we want to augment the *interaction bandwidth* between the user and the system in order to cope with this increasing complexity. In fact, most input devices capture only a few of the movements and actions the human body is capable of. Our arms and hands for instance have many degrees of freedom that are not fully exploited in common interfaces. We have recently designed new technologies to improve expressibility such as a bendable digitizer pen [36], or reliable technology for studying the benefits of finger identification on multi-touch interfaces [4].

On the output side, we want to expand users’ *interaction vocabulary*. All of the features and commands of a system can not be displayed on screen at the same time and lots of *advanced* features are by default hidden to the users (e. g., hotkeys) or buried in deep hierarchies of command-triggering systems (e. g., menus). As a result, users tend to use only a subset of all the tools the system actually offers [44]. We will study how to help them to broaden their knowledge of available functions.

Through this “opportunistic” exploration of alternative and more expressive input methods and interaction techniques, we will particularly focus on the necessary technological requirements to integrate them into interactive systems, in relation with our redesign of the I/O stack at the micro-dynamics level.

3.3.2. Spatial and temporal continuity in interaction

At a higher-level, we will investigate how such more expressive techniques affect users’ strategies when performing sequences of elementary actions and tasks. More generally, we will explore the “*continuity*” in interaction. Interactive systems have moved from one computer to multiple connected interactive devices (computer, tablets, phones, watches, etc.) that could also be augmented through a Mixed-Reality paradigm. This distribution of interaction raises new challenges from both the usability and engineering perspectives that we obviously have to consider in our main objective of revisiting interactive systems [43]. It involves the simultaneous usage of multiple devices and also the changes in the role of devices according to the location, the time, the task, contexts of use: A tablet device can be used as the main device while traveling, and it becomes an input device or a secondary monitor for continuing the same task once in the office; A smart-watch can be used as a standalone device to send messages, but also as a remote controller for a wall-sized display. One challenge is then to design interaction techniques that support seamless and smooth transitions during these spatial and temporal changes of the system in order to maintain the continuity of uses and tasks, and how to integrate these principles in future interactive systems.

3.3.3. Expressive tools for prototyping, studying, and programming interaction

Actual systems suffers from issues that keep constraining and influencing how interaction is thought, designed, and implemented. Addressing the challenges we presented in this section and making the solutions possible require extended expressiveness, and researchers and designers must either wait for the proper toolkits to appear, or “hack” existing interaction frameworks, often bypassing existing mechanisms. For instance, numerous usability problems in existing interfaces are stemming from a common cause: the lack, or untimely discarding, of relevant information about how events are propagated and changes come to occur in interactive environments. On top of our redesign of the I/O loop of interactive systems, we will investigate how to facilitate access to that information and also promote a more grounded and expressive way to describe and exploit input-to-output chains of events at every system level. We want to provide finer granularity and better-described connections between the *causes* of changes (e.g. input events and system triggers), their *context* (e.g. system and application states), their *consequences* (e.g. interface and data updates), and their *timing* [8]. More generally, a central theme of our Interaction Machine vision is to promote interaction as a first-class object of the system [33], and we will study alternative and better adapted technologies for designing and programming interaction, such as we did recently to ease the prototyping of Digital Musical Instruments [1] or the programming of animations in graphical interfaces [10]. Ultimately, we want to propose a unified model of hardware and software scaffolding for interaction that will contribute to the design of our Interaction Machine.

3.4. Macro-Dynamics

Macro-dynamics concern longer-term phenomena such as skills acquisition, learning of functionalities of the system, reflexive analysis of its own use (e. g., when the user has to face novel or unexpected situations which require high-level of knowledge of the system and its functioning). From the system perspective, it implies to better support cross-application and cross-platform mechanisms so as to favor skill transfer. It also requires to improve the instrumentation and high-level logging capabilities to favor reflexive use, as well as flexibility and adaptability for users to be able to finely tune and shape their tools.

We want to move away from the usual binary distinction between “novices” and “experts” [3] and explore means to promote and assist digital skill acquisition in a more progressive fashion. Indeed, users have a permanent need to adapt their skills to the constant and rapid evolution of the tasks and activities they carry on a computer system, but also the changes in the software tools they use [47]. And software strikingly lacks powerful means of acquiring and developing these skills [3], forcing users to mostly rely on outside support (e. g., being guided by a knowledgeable person, following online tutorials of varying quality). As a result, users tend to rely on a surprisingly limited interaction vocabulary or *make-do* with sub-optimal routines and tools [48]. Ultimately, the user should be able to master the interactive system to form durable and stabilized practices that would eventually become *automatic* and reduce the mental and physical efforts, making their interaction *transparent*.

In our previous work, we identified the fundamental factors influencing expertise development in graphical user interfaces and created a conceptual framework that characterize users’ performance improvement with UIs [7], [3]. We designed and evaluated new command selection and learning methods to leverages user’s digital skill development with user interfaces, on both desktop [6] and touch-based computers.

We are now interested in broader means to support the analytic use of computing tools:

- *to foster understanding of interactive systems.* As the digital world makes the shift to more and more complex systems driven by machine learning algorithms, we increasingly loose our comprehension of what processes yielded the system to respond in one way rather than another. We will study how novel interactive visualizations can help reveal and expose the “intelligence” behind, in ways that people better master their complexity.
- *to foster reflexion on interaction.* We will study how we can foster users’ reflexion on their own interaction in order to encourage them to acquire novel digital skills. We will build real-time and off-line software for monitoring how user’s ongoing activity is conducted at an application and system level. We will develop augmented feedbacks and interactive history visualization tools that will offer contextual visualizations to help users to better understand their activity, compare their actions to that of others, and discover possible improvement.
- *to optimize skill-transfer and tool re-appropriation.* The rapid evolution of new technologies has drastically increased the frequency at which systems are updated, often requiring to relearn everything from scratch. We will explore how we can minimize the cost of having to appropriate an interactive tool by helping users to capitalize on their existing skills when appropriating a new interactive

system.

We plan to explore these questions as well as the use of such aids in several contexts such as web-based, mobile or BCI-based applications. Although, a core aspect of this work will be to design systems and interaction techniques that will be as little platform-specific as possible, in order to better support skill-transfer. Following our Interaction Machine vision, this will lead us to rethink how interactive systems have to be engineered so that they can offer better instrumentation, higher adaptability, and fewer separation between applications and tasks in order to support reuse and skills transfer.

4. Application Domains

4.1. Application Domains

Loki works on fundamental and technological aspects of Human-Computer Interaction that can be applied to diverse application domains.
Our 2018 research concerned desktop, touch-based, haptics, and BCI interfaces with notable applications to medicine (analysis of fine motor control for patients with Parkinson disease), digital humanities (interpretation of handwritten historical documents), as well as creativity support tools (production of illustrations, design of Digital Musical Instruments).

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Personnel

Géry Casiez has been appointed junior member of the Institut Universitaire de France.

Géry Casiez has been appointed at the rank of Adjunct Professor by the University of Waterloo, Canada (2018-2020).

5.1.2. Publications

Loki presented 6 papers at ACM CHI and 1 paper at ACM UIST, the most prestigious conferences in our field.

5.1.3. Awards

“Honorable mention” (top 4% of the 2500+ submissions) from the ACM CHI conference to the paper “Storyboard-Based Empirical Modelling of Touch Interface Performance”, from A. Goguey, G. Casiez, A. Cockburn, & C. Gutwin .

BEST PAPER AWARD:

[19]
A. GOGUEY, G. CASIEZ, A. COCKBURN, C. GUTWIN. *Storyboard-Based Empirical Modeling of Touch Interface Performance*, in "Adjunct Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 2018), Demonstration", Montreal, Canada, April 2018 [*DOI :* 10.1145/3170427.3186479], https://hal.inria.fr/hal-01736699

6. New Software and Platforms

6.1. ParkEvolution

Longitudinal analysis of fine motor movement in an ecological context for patients with Parkinson disease

KEYWORD: Parkinson disease
FUNCTIONAL DESCRIPTION: The originality of this application relies on the acquisition of data in an ecological context. Thanks to this application that patients download on their personal computer, the data corresponding to cursor displacement on screen and raw input from pointing devices are collected, encrypted and sent to a server. The analysis of this data allows to compute a motor score according to the parameters of movement, in order to identify alterations in fine motor control. We ensure a realistic score based on the important quantity of data collected. This software is written in C++ and runs on Windows. It uses the libpointing library to access raw data from pointing devices.

RELEASE FUNCTIONAL DESCRIPTION: Fixed bugs and developed new features.
NEWS OF THE YEAR: Release of the 1.3.0 version fixing a number of bugs and introducing a number of new small features. An APP request is close of getting approved.

- Participants: Géry Casiez and Laure Fernandez
- Partners: Aix-Marseille Université - CNRS Laboratoire de Psychologie Cognitive - UMR 7290 - Team 'Perception and attention' - Institut de Neurosciences de la Timone
- Contact: Géry Casiez
- URL: http://parkevolution.org/

6.2. liblag

Library implementing latency compensation techniques for interactive systems
KEYWORDS: Interaction - Latency
FUNCTIONAL DESCRIPTION: The library comprises the management of a set of multitouch input devices, the implementation of latency compensation techniques from the state-of-the-art and new latency compensation techniques developed in the project, and a system to handle artificial latency.

The library is developed in C++ using the Qt framework to allow compiling the same code on a wide range of devices and platforms.
NEWS OF THE YEAR: Finished the work on the latency compensation algorithm "TurboTouch predictor" and development of the demonstrator presented at Euratechnologies. Development of an on-line interactive demo available at http://ns.inria.fr/loki/TTp/

- Contact: Géry Casiez
- Publications: Dispositif à affichage prédictif - Next-Point Prediction for Direct Touch Using Finite-Time Derivative Estimation
- URL: http://mjolnir.lille.inria.fr/turbotouch/

7. New Results

7.1. Introduction

According to our research program, in the next two to five years, we will study dynamics of interaction along three levels depending on interaction time scale and related user's perception and behavior: *Micro-dynamics*, *Meso-dynamics*, and *Macro-dynamics*. Considering phenomena that occur at each of these levels as well as their relationships will help us to acquire the necessary knowledge (Empowering Tools) and technological bricks (Interaction Machine) to reconcile the way interactive systems are designed and engineered with human abilities. Although our strategy is to investigate issues and address challenges for all of the three levels of dynamics, our immediate priority is to focus on micro-dynamics since it concerns very fundamental knowledge about interaction and relates to very low-level parts of interactive systems, which is likely to influence our future research and developments at other levels.

7.2. Micro-dynamics

Participants: Axel Antoine, Géry Casiez [correspondent], Sylvain Malacria, Mathieu Nancel, Thomas Pietrzak.

7.2.1. Latency & Transfer functions

End-to-end latency in interactive systems is detrimental to performance and usability, and comes from a combination of hardware and software delays. While these delays are steadily addressed by hardware and software improvements, it is at a decelerating pace. In parallel, short-term input prediction has recently shown promising results to compensate for latency, in both research and industry.

in the context of the collaborative Turbotouch project, we introduced a new prediction algorithm for direct touch devices based on (i) a state-of-the-art finite-time derivative estimator, (ii) a smoothing mechanism based on input speed, and (iii) a post-filtering of the prediction in two steps (see Figure 2 left). Using both a preexisting dataset of touch input as benchmark, and subjective data from a new user study, we showed that this new predictor outperforms those currently available in the literature and industry, based on metrics that model user-defined negative side-effects caused by input prediction. In particular, our predictor can predict up to 2 or 3 times further than existing techniques with minimal negative side-effects [23].

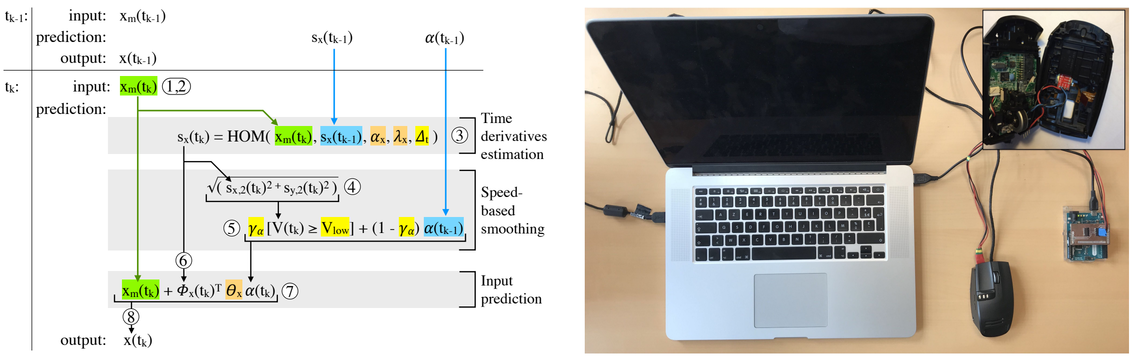

Figure 2. (left) General description of our real-time input prediction method, with step numbers. Input in green, previously computed variables in blue, general parameters in yellow, optimized parameters in orange. (right) Our hybrid setup for input prediction comprises a Logitech G9 Laser Mouse connected via USB to the host computer with the MPU-9250 chip embedded inside, which is itself connected to an Arduino board.

We also proposed a hybrid hardware and software input prediction technique specifically designed for partially compensating end-to-end latency in indirect pointing (see Figure 2 right). We combined a computer mouse with a high frequency accelerometer to predict the future location of the pointer using Euler based equations. Our prediction method results in more accurate prediction than previously introduced prediction algorithms for direct touch. A controlled experiment also revealed that it can improve target acquisition time in pointing tasks [15], [28].

Finally, on the topic of transfer functions we performed some preliminary analysis of the kinematics of a pointing task with varying linear velocity based transfer functions to assess how we use vision and haptics to plan and control our movement [25].

7.2.2. Understanding touch interaction

Atomic interactions in touch interfaces, like tap, drag, and flick, are well understood in terms of interaction design, but less is known about their physical performance characteristics. We conducted a study to gather baseline data about finger pitch and roll orientation during atomic touch input actions [21]. Our results showed differences in orientation and range for different fingers, hands, and actions: for a given hand, the little, ring and middle fingers are used in a similar manner, whereas the thumb uses different range of orientations. Additional analyses about how changing the angle of the tablet affects people's finger orientations suggest that ranges of orientation tighten as the tablet pitch increases. This data provides designers and researchers with better understanding of what kind of interactions are possible in different settings (e. g., using the left or right hand), to design novel interaction techniques that use orientation as input (e. g., using finger tilt as an implicit mode), and to anticipate the feasibility of new sensing techniques (e. g., using fingerprints for identifying specific finger touches).

7.3. Meso-dynamics

Participants: Marc Baloup, Géry Casiez, Stéphane Huot, Edward Lank, Sylvain Malacria, Mathieu Nancel, Thomas Pietrzak [correspondent], Thibault Raffaillac, Marcelo Wanderley.

7.3.1. Improving interaction bandwidth and expressiveness

Despite the ubiquity of touch-based input and the availability of increasingly computationally powerful touchscreen devices, there has been comparatively little work on enhancing basic canonical gestures such as swipe-to-pan and pinch-to-zoom. We introduced transient pan and zoom, i. e., pan and zoom manipulation gestures that temporarily alter the view and can be rapidly undone [16]. Leveraging typical touchscreen support for additional contact points, we designed our transient gestures so that they co-exist with traditional pan and zoom interaction. In addition to reducing repetition in multi-level navigation, our transient pan-and-zoom also facilitates rapid movement between document states.

Image editing software feature various pixel selection tools based on geometrical (rectangle, ellipses, polygons) or semantical (magic wand, selection brushes) data from the image. They are efficient in many situations, but are limited when selecting bitmap representations of handwritten text for e. g., interpreting scanned historical documents that cannot be reliably analyzed by automatic OCR methods: strokes are thin, with many overlaps and brightness variations. We have designed a new selection tool dedicated to this purpose [27]: a cursor based brush selection tool with two additional degrees of freedom: brush size and brightness threshold. The brush cursor displays feedforward clues that indicates the user which pixels will be selected upon pressing the mouse button. This brush provides a fine grain control to the user over the selection.

Figure 3. A four-dimensional selection brush for digitized handwritten documents. Red pixels will be selected, blue pixels will not.

7.3.2. Interacting with specific setups (Large-Displays, Virtual & Augmented Reality)

Large displays are becoming commonplace at work, at home, or in public areas. Handheld devices such as smartphones and smartwatches are ubiquitous, but little is known on regarding how these devices could be used to point at remote large displays. We conducted a survey on possession and use of smart devices, as well as a controlled experiment comparing seven distal pointing techniques on phone or watch, one- and two-handed, and using different input channels and mappings [26]. Our results favor using a smartphone as a trackpad, but also explore performance tradeoffs that can inform the choice and design of distal pointing techniques for different contexts of use.

In virtual reality environments, raycasting is the most common target pointing technique. However, performance on small and distant targets is impacted by the accuracy of the pointing device and the user's motor skills. Existing pointing facilitation techniques are currently only applied in the context of a virtual hand, i. e., for targets within reach. We studied how a user-controlled cursor could be added on the ray in order to enable target proximity-based pointing techniques –such as the Bubble Cursor– to be used for targets that are out of reach [17]. We conducted a study comparing several visual feedbacks for this technique (see Figure 4). Our results showed that simply highlighting the nearest target reduces the selection time by 14.8% and the error rate by 82.6% compared to standard Raycasting. For small targets, the selection time is reduced by 25.7% and the error rate by 90.8%.

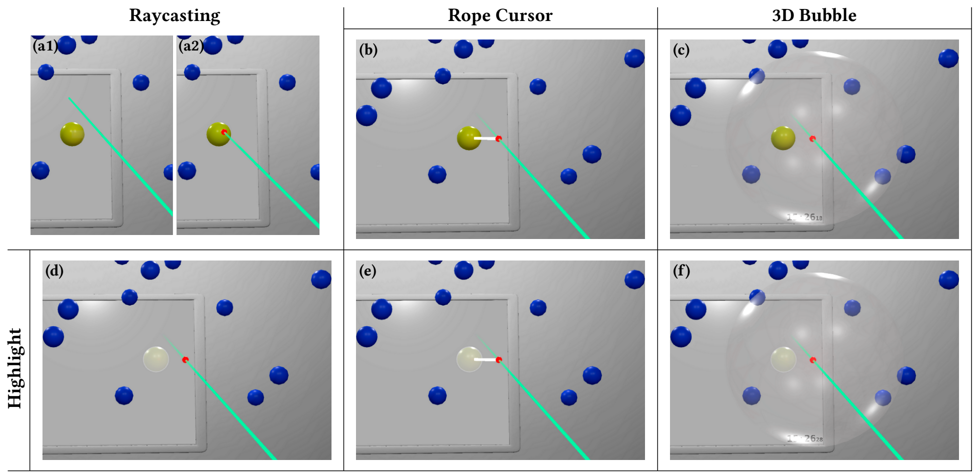

Figure 4. Visual feedback for RayCursor: (a1,a2) classical Raycasting; (b) Rope Cursor: a stroke between the closest target and the cursor; (c) 3D Bubble: a bubble centered on the cursor which contains the nearest target; (d) Highlighting on the nearest target; (e,f), highlight + rope and 3D Bubble.

Brain-Computer Interfaces (BCIs) enable users to interact with computers without any dedicated movement, bringing new hands-free interaction paradigms that could be beneficial in an Augmented Reality (AR) setup. We first tested the feasibility of using BCI in AR settings based on Optical See-Through Head-Mounted Displays (OST-HMDs) [12]. Experimental results showed that a BCI and an OST-HMD equipment (EEG headset and Hololens in our case) are well compatible and that small movements of the head can be tolerated when using the BCI. Then, we introduced a design space for command display strategies based on BCI in AR, when exploiting a famous brain pattern called Steady-State Visually Evoked Potential (SSVEP). Our design space relies on five dimensions concerning the visual layout of the BCI menu: orientation, frame-of-reference, anchorage, size and explicitness. We implemented various BCI-based display strategies and tested them within the context of mobile robot control in AR. Our findings were finally integrated within an operational prototype based on a real mobile robot that is controlled in AR using a BCI and a HoloLens headset. Taken together, our results (4 user studies) and our methodology could pave the way to future interaction schemes in Augmented Reality exploiting 3D User Interfaces based on brain activity and BCIs.

More generally, we also contributed to a reflexion on the complexity and scientific challenges associated to virtual and augmented realities [29] and the challenges to make virtual environments more closely related to the real world [30].

7.3.3. Tools for prototyping and programming interaction

Touch interactions are now ubiquitous, but few tools are available to help designers quickly prototype touch interfaces and predict their performance. On one hand, for rapid prototyping, most applications only support visual design. On the other hand, for predictive modeling, tools such as CogTool generate performance predictions but do not represent touch actions natively and do not allow exploration of different usage contexts. To combine the benefits of rapid visual design tools with underlying predictive models, we developed the *Storyboard Empirical Modeling (StEM)* tool [20], [19] for exploring and predicting user performance with touch interfaces (see Figure 5). StEM provides performance models for mainstream touch actions, based on a large corpus of realistic data. We evaluated StEM in an experiment and compared its predictions to empirical times for several scenarios. The study showed that our predictions are accurate (within 7% of empirical values on average), and that StEM correctly predicted differences between alternative designs. Our tool provides new capabilities for exploring and predicting touch performance, even in the early stages of design.

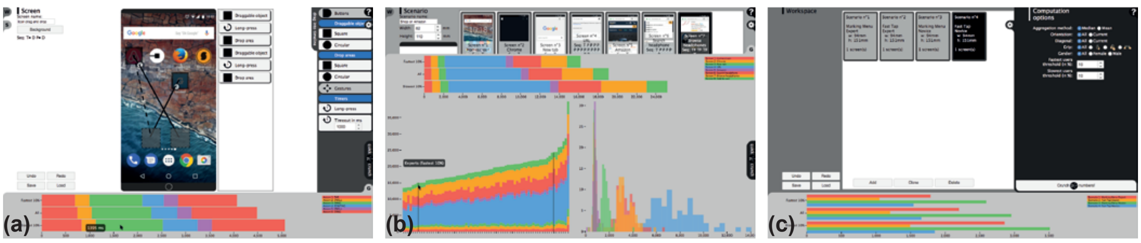

Figure 5. Storyboard Empirical Modeling (StEM): (a) users drag and drop actions onto a timeline to construct an interaction sequence; (b) users can visualize prediction times for a scenario composed of different screens; (c) users can compare scenarios, and filter the predictions according to contextual factors such as screen size or user's expertise.

Following our main objective of revisiting interactive system, we have also proposed two systems for defining and programming interactive behaviors and interactions.

Much progress has been made on interactive behavior development tools for expert programmers. However, less effort has been made in investigating how these tools support creative communities who typically struggle with technical development. This is the case, for instance, of media artists and composers working with interactive environments. To address this problem, we have introduces ZenStates [18], a new specification model for creative interactive environments that combines Hierarchical Finite-States Machines, expressions, off-the-shelf components called Tasks, and a global communication system called the Blackboard. We have implemented our model in a direct manipulation-based software interface and probed ZenStates' expressive power through 90 exploratory scenarios. we have also conducted a user study to investigate the understandability of ZenStates' model. Results support ZenStates viability, its expressiveness, and suggest that ZenStates is easier to understand –in terms of decision time and decision accuracy– compared to popular alternatives such as standard object-oriented programming and a data-flow visual language.

In a more general context, we have introduced a new GUI framework based on the *Entity-Component-System* model (ECS), where interactive elements (Entities) can acquire any data (Components) [24]. Behaviors are managed by continuously running processes (Systems) which select entities by the components they possess. This model facilitates the handling and reuse of behaviors. It allows to define the interaction modalities of an application globally, by formulating them as a set of Systems. We have implemented an experimental toolkit based on this approach, *Polyphony*, in order to demonstrate the use and benefits of this model.

7.4. Macro-dynamics

Participants: Stéphane Huot, Sylvain Malacria [correspondent], Nicole Pong.

One conspicuous feature of the current evolution of interactive devices is the spread of touch-sensitive surfaces. Typically, modern smartphones are equipped with such touch-sensitive surfaces that also support normal force-based input capabilities, which can for instance be used to control the range of a text selection by varying the force applied to the touchscreen (on e. g., iOS devices). However, this interaction mechanism is difficult to discover and many users simply ignore it exists. To overcome this problem, we introduced ForceSelect (see Figure 6, left), a force-based text selection techniques that relies on a simple mode gauge (see Figure 6, right) that does not require additional screen real-estate and help users to discover and master the use of force input in text selection tasks [22]. We conducted two studies that suggest that this mode gauge successfully provides enhanced discoverability of the force-based input and combines support for novices and experts, whereas it was never worse than the standard iOS technique and was also preferred by participants.

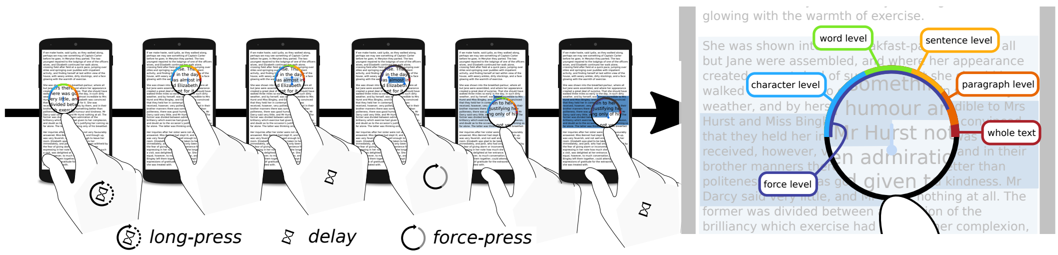

Figure 6. (left) Example of text selection using ForceSelect. The user performs a long-press that displays the callout magnifier. Keeping the force in the character level, the user adjusts its position by moving her finger. She then holds the force in the word level of the "mode gauge", locks the selection and enters the clutch mode. When force-pressing to the whole text level of the "mode gauge", she un-clutches the selection and updates it.; (right) Close-up of the "mode gauge". There are two types of text highlighting in the background: dark highlighting covers between both handles and light highlighting acts as a feedforward of which portion of text will be selected if the user released her finger (here the whole paragraph).

7.5. Interaction Machine

Several of our new results this year contributed to our global objective of building an Interaction Machine, especially at the micro-dynamics level. Our work on prediction algorithms and our hybrid hardware-software latency compensation method highlighted the need for accessing low-level input data and to have flexible input management to be able to reliably predict current finger position and compensate for latency. Our work on the characterization of the dimensions of touch interaction, especially angle of touch, highlighted the need for additional dimensions in input events that are not yet accessible in actual systems. All in all, this confirm our hypothesis that we have to redefine input management and input events propagation in order to better account for human factors in interactive systems, to extend the possibilities for designing more efficient and expressive interaction methods.

At the meso-dynamics level, our work on improving basic interaction methods in non-standard setups (e. g., VR, AR) highlighted the need for more open and flexible system architectures and tools that ease the design and prototyping of alternative interaction techniques based on mixed modalities. The new prototyping and programing tools that we proposed this year (StEM, ZenStates and Polyphony) are our first explorations toward such system-integrated frameworks dedicated to interaction.

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. GeneaLire (CPER MAuVE, 2018-2019)

Participants: Stéphane Huot, Thomas Pietrzak [correspondent].

Interactive tools for the interpretation of manuscripts

The goal of this project is to design, implement and evaluate interactive tools for helping transcription of scanned handwritten documents. Current solutions focus on automatic recognition, with recent advances thanks to deep learning methods. However these solutions still require a significant learning base that has to be made by hand. Not only this means that part of the work cannot be done automatically, but it also means that this technique is not a solution for small collections of documents. The tools we propose to create will ingeniously take advantage of interactive and automatic techniques. The interactive tools include a text selection techniques [27], as well as advanced annotation techniques that will support collaborative work. This tool will be invaluable for bootstrapping the transcription of large collections, as well as helping transcribing small collections. We will use user-centered design, in order to make sure the tool fits historians and genealogists activities and workflow.

Partners: Inria Saclay's AVIZ team, École Polytechnique de l'Université de Tours, Laboratoire de Démographie et d'Histoire Sociale at l'École des hautes études en sciences sociales, and Geneanet.

Related publication: [27]

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. TurboTouch (PRC, 2014-2019)

Participants: Géry Casiez [correspondent], Sylvain Malacria, Mathieu Nancel, Thomas Pietrzak.

High-performance touch interactions

Touch-based interactions with computing systems are greatly affected by two interrelated factors: the transfer functions applied on finger movements, and latency. This project aims at transforming the design of touch transfer functions from black art to science to support high-performance interactions. We are working on the precise characterization of the functions used and the latency observed in current touch systems. We are developing a testbed environment to support multidisciplinary research on touch transfer functions and will use this testbed to design latency reduction and compensation techniques, and new transfer functions.

Partners: Inria Lille's NON-A team and the "Perceptual-motor behavior group" from the Institute of Movement Sciences.

Web site: http://mjolnir.lille.inria.fr/turbotouch/

Related publications in 2018: [28], [15], [23], [25]

8.2.1.2. Causality (JCJC, 2019-2023)

Participant: Mathieu Nancel [correspondent].

Integrating Temporality and Causality to the Design of Interactive Systems

The project addresses a fundamental limitation in the way interfaces and interactions are designed and even thought about today, an issue we call *procedural information loss*: once a task has been completed by a computer, significant information that was used or produced while processing it is rendered inaccessible regardless of the multiple other purposes it could serve. It hampers the identification and solving of identifiable usability issues, as well as the development of new and beneficial interaction paradigms. We will explore, develop, and promote finer granularity and better-described connections between the causes of those changes, their context, their consequences, and their timing. We will apply it to facilitate the real-time detection, disambiguation, and solving of frequent timing issues related to human reaction time and system latency; to provide broader access to all levels of input data, therefore reducing the need to "hack" existing frameworks to implement novel interactive systems; and to greatly increase the scope and expressiveness of command histories, allowing better error recovery but also extended editing capabilities such as reuse and sharing of previous actions.

Web site: http://loki.lille.inria.fr/causality/

8.2.2. Inria Project Labs

8.2.2.1. BCI-LIFT (2015-2019)

Participant: Géry Casiez [correspondent].

Brain Computer Interfaces: Learning, Interaction, Feedback, Training

The goal of this large-scale initiative is to design a new generation of non-invasive Brain-Computer Interfaces (BCI) that are easier to appropriate, more efficient, and suited for a larger number of people.

Partners: Inria's ATHENA, NEUROSYS, POTIOC, HYBRID & DEMAR teams, *Centre de Recherche en Neurosciences de Lyon* (INSERM) and INSA Rouen.

Web site: https://bci-lift.inria.fr/

Related publication in 2018: [12]

8.2.2.2. AVATAR (2018-2022)

Participants: Géry Casiez, Stéphane Huot, Thomas Pietrzak [correspondent].

The next generation of our virtual selves in digital worlds

This project aims at delivering the next generation of virtual selves, or *avatars*, in digital worlds. In particular, we want to push further the limits of perception and interaction through our avatars to obtain avatars that are better embodied and more interactive. Loki's contribution in this project consists in designing novel 3D interaction paradigms for avatar-based interaction and to design new multi-sensory feedbacks to better feel our interactions through our avatars.

Partners: Inria's GRAPHDECO, HYBRID, MIMETIC, MORPHEO & POTIOC teams, Mel Slater (Event Lab, University Barcelona, Spain), Technicolor and Faurecia.

Web site: https://avatar.inria.fr/

Related publication in 2018: [17]

8.2.3. Others

8.2.3.1. ParkEvolution (Carnot Inria - Carnot STAR, 2015-2019)

Participant: Géry Casiez [correspondent].

Longitudinal analysis of fine motor control for patients with Parkinson disease

This project studies the fine motor control of patients with Parkinson disease in an ecological environment, at home, without the presence of experimenters. Through longitudinal studies, we collect raw information from pointing devices to create a large database of pointing behavior data. From the analysis of this big dataset, the project aims at inferring the individual's disease progression and influence of treatments.

Partners: the “Perceptual-motor behavior group” from the Institute of Movement Sciences and Hôpital de la Timone.

Web site: http://parkevolution.org/

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

Andy Cockburn, University of Canterbury, Christchurch, NZ [19], [20]

Carl Gutwin, University of Saskatchewan, Saskatoon, CA [19], [20], [21], [22]

Nicolai Marquardt, University College London, London, UK

Antti Oulasvirta, Aalto University, Helsinki, FI [31]

Daniel Vogel, University of Waterloo, Waterloo, CA [21]

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Edward Lank, Professor at the University of Waterloo, has spent two years in our team until Aug. 2018 (funded by Région Hauts-de-France, Université Lille and Inria).

Marcelo Wanderley, Professor at McGill University, who has been awarded an Inria International Chair in our team in 2016, spent 3 months in our group this year (July to September).

8.4.2. Visits to International Teams

8.4.2.1. Research Stays Abroad

Géry Casiez has spent four months in the Human Computer Interaction Lab at the University of Waterloo (September to December).

9. Dissemination

9.1. Promoting Scientific Activities

9.1.1. Scientific Events Organisation

9.1.1.1. Member of the Organizing Committees

- IHM (AFIHM): Stéphane Huot (Doctoral Consortium co-Chair), Thomas Pietrzak (Posters co-Chair)

9.1.2. Scientific Events Selection

9.1.2.1. Member of the Conference Program Committees

- CHI (ACM): Géry Casiez
- IHM (AFIHM): Thomas Pietrzak

9.1.2.2. Reviewer

- CHI (ACM): Sylvain Malacria, Mathieu Nancel, Thomas Pietrzak
- UIST (ACM): Géry Casiez, Sylvain Malacria, Mathieu Nancel, Thomas Pietrzak
- MobileHCI (ACM): Thomas Pietrzak
- ISS (ACM): Mathieu Nancel
- NordiCHI: Mathieu Nancel, Thomas Pietrzak

- Eurohaptics: Thomas Pietrzak
- IHM (AFIHM): Stéphane Huot, Mathieu Nancel
- NIME: Marcelo Wanderley
- GI: Mathieu Nancel

9.1.3. Journal

9.1.3.1. Member of the Editorial Boards

- Computer Music Journal: Marcelo Wanderley

9.1.3.2. Reviewer - Reviewing Activities

- Transactions on Computer-Human Interaction (ACM): Mathieu Nancel
- Virtual Environments (Frontiers): Géry Casiez
- IEEE Access (IEEE): Géry Casiez
- Behaviour & Information Technology (Taylor & Francis): Mathieu Nancel

9.1.4. Invited Talks

- *Human-Computer Interaction: Back to the future and... forward to the past*, Insights on the FUTURE of Computing conferences, Laboratoire d'Informatique de Grenoble, Grenoble: Stéphane Huot
- *Interaction Homme-Machine : passé composé et futur simple... ou l'inverse*, Collège de France Seminar – lecture of Gérard Berry (chair Algorithms, Machines and languages), Lille: Stéphane Huot
- *The measure and compensation of latency in touch and mouse-based systems*, DGP, Toronto, Canada: Géry Casiez
- *The measure and compensation of latency in touch and mouse-based systems*, Google, Waterloo, Canada: Géry Casiez
- *Motion Capture of Music Performances: Overview of almost 2 decades of research*, RITMO International Motion Capture Workshop, Oslo, Norway: Marcelo Wanderley (Keynote Speaker)

9.1.5. Leadership within the Scientific Community

Association Francophone d'Interaction Homme-Machine (AFIHM):

- Stéphane Huot: member of the scientific council
- Thomas Pietrzak: board member and webmaster until Oct. 2018

9.1.6. Scientific Expertise

- Agence Nationale de la Recherche: Stéphane Huot (mid-term review committee member)
- CN35 AFNOR normalization committee about normalizing the French keyboard, in collaboration with Aalto University and the Max Planck Institute: Mathieu Nancel
- FWO Research Foundation - Flanders: Géry Casiez (reviewer)
- Région Aquitaine: Géry Casiez, Sylvain Malacria (reviewer)

9.1.7. Research Administration

9.1.7.1. For Inria

- International relations working group (COST-GTRI): Stéphane Huot (member)

9.1.7.2. For Inria Lille – Nord Europe

- "Bureau du comité des équipes projets" (BCEP): Stéphane Huot (member)
- Research jobs committee (CER): Sylvain Malacria (member since Jan. 2018)
- Operational legal and ethical risk assessment committee (COERLE): Stéphane Huot (local correspondent)

9.1.7.3. For the CRIStAL lab of Univ. Lille & CNRS

- Direction board: Géry Casiez (deputy director since Sept. 2018)
- Laboratory council: Géry Casiez (member until Aug. 2018)
- Computer Science PhD recruiting committee: Géry Casiez (member)

9.1.7.4. For the Université de Lille

- Coordinator for internships at IUT A: Géry Casiez
- Computer Science Department council: Thomas Pietrzak

9.1.8. Hiring committees

- Inria's eligibility jury for Junior Researcher Positions (CRCN) in Lille: Stéphane Huot (vice-president)
- Université de Lille hiring committee for a Computer Science Assistant Professor position: Géry Casiez (president)
- Université Paris-Saclay hiring committees for Computer Science Assistant Professor positions: Géry Casiez (member), Stéphane Huot (member)

9.2. Teaching - Supervision - Juries

9.2.1. Teaching

DUT Informatique: Géry Casiez (38h), Stéphane Huot (28h), *IHM*, 1st year, IUT A de Lille - Univ. Lille

Licence Informatique: Thomas Pietrzak, *Logique*, 52.5h, L3, Univ. Lille

Licence Informatique: Thomas Pietrzak, *Automates et Langages*, 36h, L3, Univ. Lille

Licence Informatique: Thomas Pietrzak, *Image et Interaction 2D*, 10.5h, L3, Univ. Lille

Licence Sciences pour l'Ingénieur (SPI): Sylvain Malacria, *Introduction à l'Interaction Homme Machine*, 30h, L3, Institut Villebon Georges Charpak

Cursus ingénieur: Sylvain Malacria (10h), *3DETech*, IMT Lille-Douai

Master Informatique: Thomas Pietrzak (18h), *NIHM*, M2, Univ. Lille

Master Informatique: Sylvain Malacria (20h), *NIHM*, M2, Univ. Lille

Master Informatique: Géry Casiez (4h), Thomas Pietrzak (4h), *Projets*, M2, Univ. Lille

Master Informatique: Thomas Pietrzak (34.5h), Sylvain Malacria (34.5), *IHM*, M1, Univ. Lille

Master Informatique: Mathieu Nancel, *Evaluation*, 4h, M2, Univ. Lille

Master: Thomas Pietrzak (10.5h), *3DETech : 3D Digital Entertainment Technologies*, M2, IMT Lille Douai

Doctorat: Géry Casiez, *Expériences contrôlées et analyses statistiques*, École doctorale SPI

Master & Doctorat: Marcelo Wanderley (39h), MUMT-619 Input Devices for Musical Expression

9.2.2. Supervision

PhD: Amira Chalbi, *Understanding and Designing Animations in the User Interfaces*, defended in April 2018 [11], advised by Nicolas Roussel & Fanny Chevalier

PhD in progress: Marc Baloup, *Interaction with avatars in immersive virtual environments*, started Oct. 2018, advised by Géry Casiez & Thomas Pietrzak

PhD in progress: Axel Antoine, *Helping Users with Interactive Strategies*, started Oct. 2017, advised by Géry Casiez & Sylvain Malacria

PhD in progress: Nicole Ke Chen Pong, *Understanding and Improving Users Interactive Vocabulary*, started Oct. 2016, advised by Nicolas Roussel, Sylvain Malacria & Stéphane Huot

PhD in progress: Thibault Raffaillac, *Languages and System Infrastructure for Interaction*, started Oct. 2015, advised by Stéphane Huot

PhD in progress: Hakim Si Mohammed, *Improving Interaction Based on a Brain-Computer Interface*, started Oct. 2016, advised by Anatole Lecuyer, Ferran Argelaguet, Géry Casiez & Nicolas Roussel (in Rennes)

PhD in progress: Jeronimo Barbosa, *Design and Evaluation of Digital Musical Instruments*, McGill University, started in 2013, advised by Marcelo Wanderley & Stéphane Huot (in Montréal)

9.2.3. Juries

Jeff Avery (PhD, Univ. Waterloo, Canada): Géry Casiez, examiner

Antoine Costes (PhD, Univ. Bretagne Loire): Géry Casiez, reviewer

Bruno Fruchard (PhD, Univ. Paris-Saclay): Géry Casiez, reviewer

Julien Gori (PhD, Univ. Paris-Saclay): Stéphane Huot, examiner

Wanyu Liu (PhD, Univ. Paris-Saclay): Géry Casiez, reviewer

Gary Perelman (PhD, Univ. Toulouse III): Géry Casiez, reviewer

Houssem Saidi (PhD, Univ. Toulouse III): Stéphane Huot, reviewer

9.2.4. Mid-term evaluation committees

- Jeff Avery (PhD, Univ. Waterloo, Canada): Géry Casiez
- Delphine Poux (PhD, Univ. Lille): Géry Casiez
- Marc Teyssier (PhD, Univ. Paris-Saclay): Géry Casiez

9.3. Popularization

9.3.1. Internal or external Inria responsibilities

AIRLab selection committee for the funding of art and science projects, Stéphane Huot (representative for Inria Lille – Nord Europe)

9.3.2. Articles and contents

2067 ou la disparition des interfaces humains-machines, interview in an Inriality and Usbek & Rica joint article, Stéphane Huot

Le raccourci clavier: Une meilleure interaction entre l'Homme et la machine ?, in Lille by Inria N^{O}7, Sylvain Malacria

9.3.3. Education

Structuration et fonctionnement de la recherche, training session for academic librarians at MédiaLille, Thomas Pietrzak

9.3.4. Internal action

Chorégraphie d'animation : structurer pour mieux comprendre, talk at Inria Lille – Nord Europe "13:45", Amira Chalbi

Reliability and Perceived Reliability in Ubiquitous Gestural Input, talk at Inria Lille – Nord Europe "30 minutes de sciences", Edward Lank

The TurboTouch latency compensation method, demonstration at the opening ceremony of Bâtiment Place (Inria Lille – Nord Europe), Mathieu Nancel

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Major publications by the team in recent years

[1] F. CALEGARIO, M. WANDERLEY, S. HUOT, G. CABRAL, G. RAMALHO. *A method and toolkit for digital musical instruments: generating ideas and prototypes*, in "IEEE MultiMedia", January 2017, vol. 24, n^{O} 1, pp. 63-71, https://doi.org/10.1109/MMUL.2017.18

[2] G. CASIEZ, S. CONVERSY, M. FALCE, S. HUOT, N. ROUSSEL. *Looking through the eye of the mouse: a simple method for measuring end-to-end latency using an optical mouse*, in "Proceedings of UIST'15", ACM, November 2015, pp. 629-636, http://dx.doi.org/10.1145/2807442.2807454

[3] A. COCKBURN, C. GUTWIN, J. SCARR, S. MALACRIA. *Supporting novice to expert transitions in user interfaces*, in "ACM Computing Surveys", November 2014, vol. 47, n^o 2, http://dx.doi.org/10.1145/2659796

[4] A. GOGUEY, D. VOGEL, F. CHEVALIER, T. PIETRZAK, N. ROUSSEL, G. CASIEZ. *Leveraging finger identification to integrate multi-touch command selection and parameter manipulation*, in "International Journal of Human-Computer Studies", March 2017, vol. 99, pp. 21-36, http://dx.doi.org/10.1016/j.ijhcs.2016.11.002

[5] A. GUPTA, T. PIETRZAK, N. ROUSSEL, R. BALAKRISHNAN. *Direct manipulation in tactile displays*, in "Proceedings of CHI'16", ACM, May 2016, pp. 3683-3693, http://dx.doi.org/10.1145/2858036.2858161

[6] S. MALACRIA, G. BAILLY, J. HARRISON, A. COCKBURN, C. GUTWIN. *Promoting hotkey use through rehearsal with ExposeHK*, in "Proceedings of CHI'13", ACM, April 2013, pp. 573-582, http://doi.acm.org/10.1145/2470654.2470735

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[8] M. NANCEL, A. COCKBURN. *Causality: a conceptual model of interaction history*, in "Proceedings of CHI'14", ACM, April 2014, pp. 1777-1786, http://dx.doi.org/10.1145/2556288.2556990

[9] M. NANCEL, D. VOGEL, B. DE ARAÙJO, R. JOTA, G. CASIEZ. *Next-point prediction metrics for perceived spatial errors*, in "Proceedings of UIST'16", ACM, October 2016, pp. 271-285, http://dx.doi.org/10.1145/2984511.2984590

[10] T. RAFFAILLAC, S. HUOT, S. DUCASSE. *Turning Function Calls Into Animations*, in "Proceedings of EICS'17", ACM, June 2017, 6 p. , http://doi.acm.org/10.1145/3102113.3102134

Publications of the year

Doctoral Dissertations and Habilitation Theses

[11] A. CHALBI. *Understanding and designing animations in the user interfaces*, Université lille1, April 2018, https://hal.archives-ouvertes.fr/tel-01881889

Articles in International Peer-Reviewed Journals

[12] H. SI-MOHAMMED, J. PETIT, C. JEUNET, F. ARGELAGUET-SANZ, F. SPINDLER, A. EVAIN, N. ROUSSEL, G. CASIEZ, A. LÉCUYER. *Towards BCI-based Interfaces for Augmented Reality: Feasibility, Design and Evaluation*, in "IEEE Transactions on Visualization and Computer Graphics", October 2018, pp. 1-12 [*DOI :* 10.1109/TVCG.2018.2873737], https://hal.inria.fr/hal-01947344

[13] O. ZINENKO, S. HUOT, C. BASTOUL. *Visual Program Manipulation in the Polyhedral Model*, in "ACM Transactions on Architecture and Code Optimization", March 2018, vol. 15, n^o 1, pp. 1 - 25 [*DOI :* 10.1145/3177961], https://hal.inria.fr/hal-01744426

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