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Activity Report 2018

Project-Team POTIOC

Popular interaction

RESEARCH CENTER
Bordeaux - Sud-Ouest

THEME
Interaction and visualization

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Project-Team POTIOC

Creation of the Team: 2012 January 01, updated into Project-Team: 2014 January 01

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1. Team, Visitors, External Collaborators

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2. Overall Objectives

2.1. Overall Objectives

The standard human-computer interaction paradigm based on mice, keyboards, and 2D screens, has shown undeniable benefits in a number of fields. It perfectly matches the requirements of a wide number of interactive applications including text editing, web browsing, or professional 3D modeling. At the same time, this paradigm shows its limits in numerous situations. This is for example the case in the following activities: i) active learning educational approaches that require numerous physical and social interactions, ii) artistic performances where both a high degree of expressivity and a high level of immersion are expected, and iii) accessible applications targeted at users with special needs including people with sensori-motor and/or cognitive disabilities.

To overcome these limitations, Potioc investigates new forms of interaction that aim at pushing the frontiers of the current interactive systems. In particular, we are interested in approaches where we vary the level of *materiality* (i.e., with or without physical reality), both in the output and the input spaces. On the output side, we explore mixed-reality environments, from fully virtual environments to very physical ones, or between both using hybrid spaces. Similarly, on the input side, we study approaches going from brain activities, that require no physical actions of the user, to tangible interactions, which emphasize physical engagement. By varying the level of materiality, we adapt the interaction to the needs of the targeted users.

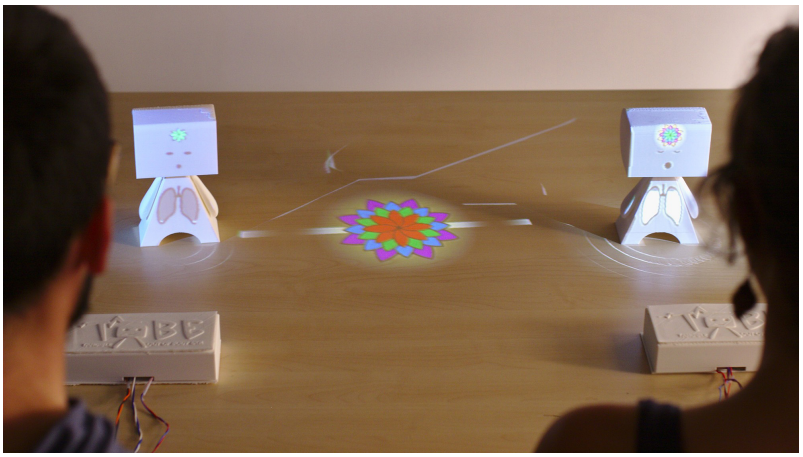

Figure 1. Tobe combines tangible interaction, spatial augmented reality, and physiological computing. It allows users to feel and explore their inner states.

The main applicative domains targeted by Potioc are Education, Art, Entertainment and Well-being. For these domains, we design, develop, and evaluate new approaches that are mainly dedicated to non-expert users. In other words, we are interested in *popular* interaction, mainly targeted at the general public. In this context, we thus emphasize approaches that stimulate curiosity, engagement, and pleasure of use.

3. Research Program

3.1. Research Program

To achieve our overall objective, we follow two main research axes, plus one transverse axis, as illustrated in Figure 2.

In the first axis dedicated to **Interaction in Mixed-Reality spaces**, we explore interaction paradigms that encompass virtual and/or physical objects. We are notably interested in hybrid environments that co-locate virtual and physical spaces, and we also explore approaches that allow one to move from one space to the other.

The second axis is dedicated to **Brain-Computer Interfaces (BCI)**, i.e., systems enabling user to interact by means of brain activity only. We target BCI systems that are reliable and accessible to a large number of people. To do so, we work on brain signal processing algorithms as well as on understanding and improving the way we train our users to control these BCIs.

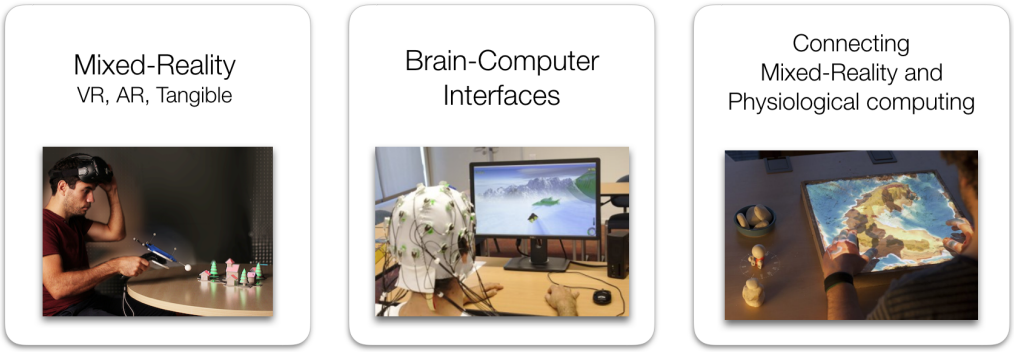

Figure 2. Main research axes of Potioc.

Finally, in the **transverse** axis, we explore new approaches that involve both mixed-reality and neuro-physiological signals. In particular, tangible and augmented objects allow us to explore interactive physical visualizations of human inner states. Physiological signals also enable us to better assess user interaction, and consequently, to refine the proposed interaction techniques and metaphors.

From a methodological point of view, for these three axes, we work at three different interconnected levels. The first level is centered on the human sensori-motor and cognitive abilities, as well as user strategies and preferences, for completing interaction tasks. We target, in a fundamental way, a better understanding of humans interacting with interactive systems. The second level is about the creation of interactive systems. This notably includes development of hardware and software components that will allow us to explore new input and output modalities, and to propose adapted interaction techniques. Finally, in a last higher level, we are interested in specific application domains. We want to contribute to the emergence of new applications and usages, with a societal impact.

4. Application Domains

4.1. Education

Education is at the core of the motivations of the Potioc group. Indeed, we are convinced that the approaches we investigate—which target motivation, curiosity, pleasure of use and high level of interactivity—may serve education purposes. To this end, we collaborate with experts in Educational Sciences and teachers for exploring new interactive systems that enhance learning processes. We are currently investigating the fields of astronomy, optics, and neurosciences. We are also working with special education centres for the blind on accessible augmented reality prototypes. In the future, we will continue exploring new interactive approaches dedicated to education, in various fields. Popularization of Science is also a key domain for Potioc. Focusing on this subject allows us to get inspiration for the development of new interactive approaches.

4.2. Art

Art, which is strongly linked with emotions and user experiences, is also a target area for Potioc. We believe that the work conducted in Potioc may be beneficial for creation from the artist point of view, and it may open new interactive experiences from the audience point of view. As an example, we are working with colleagues who are specialists in digital music, and with musicians. We are also working with jugglers and mockup builders with the goal of enhancing interactivity and user experience.

4.3. Entertainment

Similarly, entertainment is a domain where our work may have an impact. We notably explored BCI-based gaming and non-medical applications of BCI, as well as mobile Augmented Reality games. Once again, we believe that our approaches that merge the physical and the virtual world may enhance the user experience. Exploring such a domain will raise numerous scientific and technological questions.

4.4. Well-being

Finally, well-being is a domain where the work of Potioc can have an impact. We have notably shown that spatial augmented reality and tangible interaction may favor mindfulness activities, which have been shown to be beneficial for well-being. More generally, we explore *introspectibles* objects, which are tangible and augmented objects that are connected to physiological signals and that foster introspection. We explore these directions for general public, including people with special needs.

5. Highlights of the Year

5.1. Highlights of the Year

- Inner Garden will be presented at CES 2019 for which the Ullo company won an award ”Tech for a better world”
- Publication of "Virtual Reality and Augmented Reality: Myths and Realities" [42]. This book has been written by 30 academics and engineers working in french labs and companies under the supervision of Bruno Arnaldi (INSA Rennes), Pascal Guitton (Potioc) and Guillaume Moreau (Centrale Nantes). It discusses various aspects : hardware, software, applications, ethics issues... It covers the previous 10 years and give some prospective elements for the future. (the french edition is also available [41]).
- Winner of Bourse Déclic jeunes, Fondation de France, Lauren Thévin

5.1.1. Awards

- Best Demonstration award IHM 2018 [61],
- Hackathon BR41N.IO, 7th BCI Meeting 2018, Asilomar, May 20-21st 2018, 1st winning group, Léa Pillette
- UIST conference hackathon winner, Berlin, Germany, October 2018, Aurélien Appriou
- Student Travel Award (Asilomar BCI Meeting, California) (May 2018), Jelena Mladenovic
- Student Travel Award (UbiComp conference, Singapore) (October 2018), Jelena Mladenovic

6. New Software and Platforms

6.1. Aïana

KEYWORD: Multimedia player
FUNCTIONAL DESCRIPTION: This software aims to make accessible the playing of a MOOC composed of various information flows (boards, videos, subtitles ...). It is not intended to be "reserved" for people with disabilities but rather to be open to as many as possible by allowing each user to adapt the interface, and therefore the use, to its users own capabilities and needs.

- Authors: Damien Caselli, Pierre-Antoine Cinquin, Pascal Guitton and Hélène Sauzéon
- Partner: Université de Bordeaux
- Contact: Pascal Guitton
- Publications: Towards Truly Accessible MOOCs for Persons with Cognitive Disabilities: Design and Field Assessment - Online e-learning and cognitive disabilities: A systematic review

6.2. HybridOptics : Hybrid Optical Platform

KEYWORDS: Augmented reality - Education - Tangible interface
FUNCTIONAL DESCRIPTION: The software platform - gets the values of the sensors - computes in real-time the result of the simulation - generates pedagogical supports that are directly linked to the simulation (projected on the work table) - allows the user to control several parameters from a dedicated application on a tablet

- Participants: Benoît Coulais, Lionel Canioni, Bruno Bousquet, Martin Hachet and Jean-Paul Guillet
- Contact: Martin Hachet
- URL: https://project.inria.fr/hobit/

6.3. Platforms

6.3.1. HOBIT

In 2018, we have continued working on the HOBIT platform dedicated to teaching and training of Optics at University. We have notably improved the hardware side, as illustrated in Figure 3.

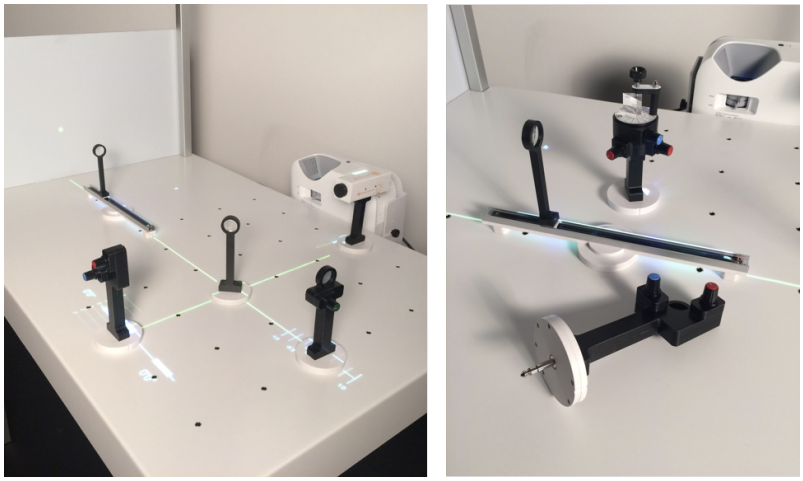

Figure 3. The new version of HOBIT. Users can easily plug fake optical components (e.g. source lights, mirrors and lens) anywhere on the table to build their optical experiment.

7. New Results

7.1. Transition between AR and VR spaces

Participants: Joan Sol Roo, Martin Hachet, Pierre-Antoine Cinquin

Mixed Reality systems combine physical and digital worlds, with great potential for the future of HCI. It is possible to design systems that support flexible degrees of virtuality by combining complementary technologies. In order for such systems to succeed, users must be able to create unified mental models out of heterogeneous representations. We conducted two studies focusing on the users' accuracy on heterogeneous systems using Spatial Augmented Reality (SAR) and immersive Virtual Reality (VR) displays (see Figure 4), and combining viewpoints (egocentric and exocentric). The results show robust estimation capabilities across conditions and viewpoints [31].

Figure 4. A user experiencing transitions between spatial augmented reality and virtual reality spaces.

7.2. Tangible and augmented interfaces for Schoolchildren

Participants: Philippe Giraudeau, Théo Segonds, Martin Hachet

In 2018, we have continued working on the exploration of tangible and augmented interfaces for Schoolchildren. We have notably evaluated the pedagogical potential of Teegi in a user study conducted at school [24].

We have also pursued our work on collaborative learning at school, part of the e-Tac project. In particular, based on focus group with children and practitioners, we have refined our interactive pedagogical environment, and we have implemented a new version (see Figure 5) [53]

Figure 5. Tangible and augmented objects to foster collaborative learning at school.

7.3. Ambient interfaces dedicated to the awareness of energy consumption

Participants: Pierre-Antoine Cinquin, Philippe Giraudeau

Inspired by studies in data physicalization, we explore the use of tangible and ambient interfaces to raise people's awareness of energy consumption. As a first approach, we are developing an interactive and collaborative environment named Erlen. This year, we have designed a first prototype taking the form of an Erlenmeyer flask with fluid simulation. Through manipulation, users can visualize information about their electricity consumption. This prototype was demonstrated at IHM 2018 [21]. Based on the feedback we obtained, we are actually developing a new set of individuals and shared interfaces along with new interactions.

7.4. Drones for Human interaction

Participants: Rajkumar Darbar, Anke Brock, Martin Hachet.

We have also continued working with drones. In particular, we have proposed FlyMap as a novel user experience for interactive maps projected from a drone. We iteratively designed three interaction techniques for FlyMap's usage scenarios. In a comprehensive indoor study (N = 16), we show the strengths and weaknesses of the techniques on users' cognition, task load and satisfaction. We then pilot tested FlyMap outdoors in real world conditions with four groups of participants. We show that its interactivity is exciting to users, opening the space for more direct interactions with drones [20].
We are currently exploring the use of drones to bring passive haptic feedback in immersive VR scenario. Concretely, we are building a system where drones, equipped with flat panels, co-locate themselves with virtual objects to provide physical feedbacks to VR users.

7.5. Mixed reality based interfaces for visual impaired persons

Participant: Lauren Thévin, Anke Brock

Current low-tech Orientation & Mobility (O&M) tools for visually impaired people, e.g. tactile maps, possess limitations. Interactive accessible maps have been developed to overcome these. However, most of them are limited to exploration of existing maps, and have remained in laboratories. Using a participatory design approach, we have worked closely with 15 visually impaired students and 3 O&M instructors over 6 months. We iteratively designed and developed an augmented reality map destined at use in O&M classes in special education centers. This prototype combines projection, audio output and use of tactile tokens, and thus allows both map exploration and construction by low vision and blind people. Our user study demonstrated that all students were able to successfully use the prototype, and showed a high user satisfaction. A second phase with 22 international special education teachers allowed us to gain more qualitative insights. This work shows that augmented reality has potential for improving the access to education for visually impaired people [18].

We have pursued this work to make the visual and audio augmentation of real objects easy and convenient. In a user study, six teachers created their own audio-augmentation of objects, such as a botanical atlas (Figure 6, within 30 minutes or less. Teachers found the tool easy to use and were confident about re-using it. Participants found the resulting interactive graphics exciting to use independently of their mental imagery skills [32].

7.6. Accessibility of e-learning systems

Participants: Pierre-Antoine Cinquin, Damien Caselli and Pascal Guitton

In 2018, we continued to work on new digital teaching systems such as MOOCs. Unfortunately, accessibility for people with disabilities is often forgotten, which excludes them, particularly those with cognitive impairments for whom accessibility standards are fare from being established. We have shown in [11] that very few research activities deal with this issue.

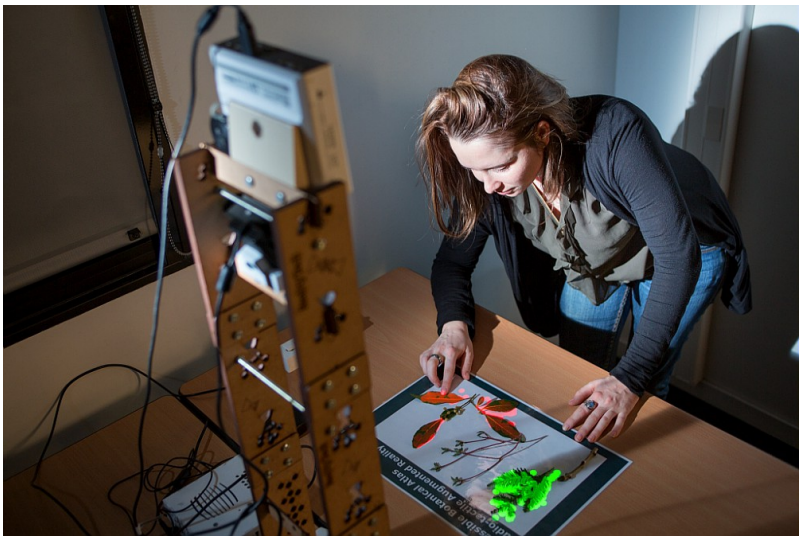

Figure 6. Multimodal Augmented Reality for visual impaired students.

In past years, we have proposed new design principles based on knowledge in the areas of accessibility (Ability-based Design and Universal Design), digital pedagogy (Instruction Design with functionalities that reduce the cognitive load : navigation by concept, slowing of the flow...), specialized pedagogy (Universal Design for Learning, eg, automatic note-taking, and Self Determination Theory, e.g., configuration of the interface according to users needs and preferences) and psychoducational interventions (eg, support the joint teacher-learner attention), but also through a participatory design approach involving students with disabilities and experts in the field of disability. From these framework, we have designed interaction features which have been implemented in a specific MOOC player called Aïana. Moreover, we have produced a MOOC on digital accessibility which is published on the national MOOC platform (FUN) using Aïana (4 sessions since 2016 with more than 9000 registered participants). https://mooc-francophone.com/cours/mooc-accessibilite-numerique/. Our first field studies demonstrate the benefits of using Aïana for disabled participants [22].

7.7. Improving EEG Signal Processing for Brain-Computer Interfaces

Participants: Aurélien Appriou, Satyam Kumar, Fabien Lotte

A review of classification algorithms for BCI: Most current Electroencephalography (EEG)-based Brain-Computer Interfaces (BCIs) are based on machine learning algorithms. We surveyed the BCI and machine learning literature to identify the classification approaches that have been investigated to design BCIs. We found that the recently designed classification algorithms for EEG-based BCIs can be divided into four main categories: adaptive classifiers, matrix and tensor classifiers, transfer learning and deep learning, plus a few other miscellaneous classifiers. Among these, adaptive classifiers were demonstrated to be generally superior to static ones, even with unsupervised adaptation. Transfer learning can also prove useful although the benefits of transfer learning remain unpredictable. Riemannian geometry-based methods have reached state-of-the-art performances on multiple BCI problems and deserve to be explored more thoroughly, along with tensor-based methods. Shrinkage linear discriminant analysis and random forests also appear particularly useful for small training samples settings. On the other hand, deep learning methods have not yet shown convincing and consistent improvement over state-of-the-art BCI methods. This survey was published in Journal of Neural Engineering in [14].

Figure 7. The Aïana MOOC player.

Exploring Modern Machine Learning Methods to Estimate Mental Workload From EEG Signals: Estimating mental workload from brain signals such as EEG has proven very promising in multiple HCI applications, e.g., to design games or educational applications with adaptive difficulty. However, currently obtained workload classification accuracies are relatively low, making the resulting estimations not fully trustable. We thus studied promising modern machine learning algorithms, including Riemannian geometry-based methods and Convolutional Neural Networks, to estimate workload from EEG signals. We studied them with both user-specific and user-independent calibration, to go towards calibration-free systems. Our results suggested that a shallow Convolutional Neural Network obtained the best performance in both conditions, outperforming state-of-the-art methods on the used data sets. This work was published as a work-in-progress in the CHI conference [19].

BCPy, an open-source python platform for offline EEG signals decoding and analysis: Although promising, BCIs are still barely used outside laboratories due to their poor robustness. Moreover, they are sensitive to noise, outliers and the non-stationarity of EEG signals. Many algorithms have been developed for EEG signals processing and classification, in order to improve BCIs robustness. We proposed BCPy, an open-source, easy-to-use python BCI platform for offline EEG signal analysis. Python is free and contains good scalable libraries for scientific computing. Moreover, Python is the major language used to implement recent advances in ML and Deep Learning, thus making them easily available for BCI research. This work was published in the International BCI meeting [48].

Adaptive Riemannian classification methods: The omnipresence of non-stationarity and noise in EEG signals restricts the ubiquitous use of BCIs. One of the possible ways to tackle this problem is to adapt the computational model used to detect and classify different mental states. Adapting the model will possibly help us to track the changes and thus reducing the effect of non-stationarities. In this paper, we present different adaptation strategies for state of the art Riemannian geometry based classifiers. The offline evaluation of our proposed methods on two different datasets showed a statistically significant improvement over baseline non-adaptive classifiers. Moreover, we also demonstrate that combining different (hybrid) adaptation strategies generally increased the performance over individual adaptation schemes. Also, the improvement in average classification accuracy for a 3-class mental imagery BCI with hybrid adaption is as high as around 17% above the baseline non-adaptive classifier. This was published in [26].

Regularized spatial filters for EEG regression problems: In collaboration with University Freiburg, we reported on novel supervised algorithms for single-trial brain state decoding. When brain activity is assessed by multichannel recordings, spatial filters computed by the source power comodulation (SPoC) algorithm allow identifying oscillatory subspaces. In small dataset scenarios, this supervised method tends to overfit to its training data. To improve upon this, we proposed and characterize three types of regularization techniques for SPoC. Evaluating all methods on real-world data, we observed an improved regression performance mainly for datasets from subjects with initially poor performance. This was published in the Neuroinformatics journal [16].

SEREEGA: a toolbox to Simulate EEG activity: EEG is a popular method to monitor brain activity, but it is difficult to evaluate EEG-based analysis methods because no ground-truth brain activity is available for comparison. Therefore, to test and evaluate such methods, in collaboration with TU Berlin, we proposed SEREEGA, a free and open-source matlab toolbox for Simulating Event-Related EEG Activity. The toolbox is available at https://github.com/lrkrol/SEREEGA. SEREEGA unifies the majority of past simulation methods reported in the literature into one toolbox. This toolbox and its use were published in journal of neuroscience methods [13].

7.8. Understanding Brain-Computer Interfaces user Training

Participants: Léa Pillette, Camille Benaroch, Fabien Lotte

Computational models of BCI performance: Mental-Imagery based BCIs (MI-BCIs) use signals produced during mental imagery tasks to control the system. Current MI-BCIs are rather unreliable, which is due at least in part to the use of inappropriate user-training procedures. Understanding the processes underlying user-training by modelling it computationally could enable us to improve MI-BCI training protocols and adapt the latter to the profile of each user. Indeed, we developed theoretical and conceptual models of BCI performances suggesting that the users' profiles does impact their performances [12]. Our objective is to create a statistical/probabilistic model of training that could explain, if not predict, the learning rate and the performances of a BCI user over training time using user's personality, skills, state and timing of the experiment. Preliminary analyses on previous data revealed positive correlations between MI-BCI performances and mental rotation scores among two of three different studies based on the same protocol [49]. This suggests that spatial abilities play a major role in MI-BCI users' abilities to learn to perform MI tasks, which is consistent with the literature.

Modeling and measuring users' skills at MI-BCI control: Studying and improving the reliability issue of BCI requires the use of appropriate reliability metrics to quantify both the classification algorithm and the BCI user's performances. So far, Classification Accuracy (CA) is the typical metric used for both aspects. However, we argued that CA is a poor metric to study BCI users' skills. Thus, we proposed a definition and new metrics to quantify such BCI skills for MI-BCIs, independently of any classification algorithm. By re-analyzing EEG data sets with such new metrics, we indeed confirmed that CA may hide some increase in MI-BCI skills or hide the user inability to self-modulate a given EEG pattern. On the other hand, our new metrics could reveal such skill improvements as well as identify when a mental task performed by a user was no different than rest EEG. This work was published in Journal of Neural Engineering [15].

Towards measuring the impact of attention: "Attention" is a generic word encompasses alertness and sustained attentions, referring to the intensity of attention (i.e., strength), as well as selective and divided attentions, referring to its selectivity (i.e., amount of monitored information). BCI literature indicates an influence of both users' attention traits and states (i.e., respectively stable and unstable attentional characteristics) on the ability to control a BCI. Though the types of attention involved remain unclear. Therefore, assessing which types of attention are involved during BCI use might provide information to improve BCI usability. Before testing this hypothesis, we first needed to assess if the different types of attention are recognizable using EEG. Our first results suggested that indeed, using machine learning, we can discriminate attention types for each other in EEG, at least when comparing them two by two [59].

The Influence of the experimenter: Through out the research and development process of MI-BCI, human supervision (e.g., experimenters or caregivers) plays a central role. People need to present the technology to users and ensure the smooth progress of the BCI learning and use. Though, very little is known about the influence they might have on their results. Such influence is to be expected as social and emotional feedback were shown to influence MI-BCI performances and user experience. Furthermore, literature from different fields indicate an effect of experimenters, and specifically their gender, on experiment outcome. Therefore, we assessed the impact of gender on MI-BCI performances, progress and user experience. An interaction of the runs, subjects gender and experimenters gender was found to have an impact on the performances of the subjects, suggesting users learn better with female experiments [30] (see Fig. 8).

Figure 8. An EEG cap is being placed on the head of a subject by an experimenter on the right while another experimenter on the left is setting up the necessary software on the computer.

7.9. Improving BCI user performance and training

Participants: Jelena Mladenovic, Léa Pillette, Thibaut Monseigne, Fabien Lotte

The potential of learning companions: As mentioned before, current BCI training protocols do not enable every user to acquire the skills required to use BCIs. We showed that learning companions were promising tools to increase BCI user experience during training, as well as to increase the performances of users who are more inclined to work in a group. Encouraged by these first results we investigated all the other potential benefits learning companions could bring to BCI training by improving the feedback, i.e., the information provided to the user, which is primordial to the learning process and yet have proven both theoretically and practically inadequate in BCI. From these considerations, some guidelines were drawn, open challenges identified and potential solutions were suggested to design and use learning companions for BCIs [29].

Active Inference for P300 speller: Brain Computer Interface (BCI) mostly relies, on one hand, on the stability of a person's mental commands, and on the other, on the machine's capacity to interpret those commands. As a person is naturally changing and adapting all the time, the machine becomes less successful in interpreting user's commands. In turn, the machine should be able to predict and minimize undesired user fluctuations. Moreover, it should build bottom-up information about the user through physiological input (EEG observations), and influence the user by providing optimal task (action) to minimize prediction error. A novel neuroscience approach, Active (Bayesian) Inference, is a very generic and flexible computational framework that can predict user intentions through a series of optimal actions and observations. On simulated data, we have shown that Active Inference has great potential to enable the machine to co-adapt with the user, and increase performance levels in a P300 speller BCI. We further tested Active Inference on real data, and show that active inference surpasses the standard algorithms while permitting the implementation of various cases of p300 speller BCI within one single framework [57].

Towards Congruent Feedback for BCI: Congruent visual environment in MI BCI has been researched in virtual reality, giving a sense of body ownership illusion, and showed to be more robust and improve performance. On the other hand, the effects of a congruent, purely audio environment, have not yet been explicitly explored in BCI. This inspired us to explore the benefits of a task-related (congruent) and synchronised audio feedback which would comply with the user's imagined movements. We investigate the potential of such an audio feedback congruent to the task, tackling the sensory illusion of presence by providing realistic audio feedback using natural sounds. Our preliminary results show the benefits of a congruent, audio MI feedback of feet (sound of footsteps in gravel) as opposed to no congruent feedback using abstract sound [50].

Neurofeedback of daytime alertness: Neurofeedback consists in providing a subject with information about his own EEG by means of a sensory feedback (visual, auditory ...) in real-time, in order to enable cognitive learning. In collaboration with SANPSY (Pellegrin Hospital/Univ. Bordeaux), we implemented a complete Neurofeedback solution as a proof of concept that aims to determine the level of effectiveness of Neurofeedback on daytime alertness ability. Indeed, excessive daytime sleepiness (EDS) is a common complaint associated with increased accidental risk. The usual countermeasures such as blue light, caffeine or nap have been shown to be effective but have limitations. With a test on five subjects, preliminary data showed that it was possible to learn how to regulate our own EEG activity with a short number of sessions (8 sessions of 40 min). Clinical trials to confirm these results should be initiated in the course of 2019.

7.10. Physiological computing

Participants: Jelena Mladenovic, Fabien Lotte

ElectroGastoGraphy: Recent research in the enteric nervous system, sometimes called the second brain, has revealed potential of the digestive system in predicting emotions. Even though people regularly experience changes in their gastrointestinal (GI) tract which influence their mood and behavior multiple times per day, robust measurements and wearable devices are not quite developed for such phenomena. However, other manifestations of the autonomic nervous system such as electrodermal activity, heart rate, and facial muscle movement have been extensively used as measures of emotions or in biofeedback applications, while neglecting the gut. In [28], we exposed electrogastrography (EGG), i.e., recordings of the myoelectric activity of the GI tract, as a possible measure for inferring human emotions.

EEG-based neuroergonomics: In collaboration with ISAE Toulouse, we explored the use of EEG to monitor cognitive processes in real flight situation, using dry EEG sensors. We showed that doing so is possible, however with low performances, given the strong noise in signals occurring in this challenging context [23]. In general, we presented in [17] and [40] how BCIs could be useful for neuroergonomics, i.e., to estimate user interfaces ergonomics quality from neurophysiological measures. Finally, in collaboration with RIKEN BSI, Japan, we showed that emotions could be monitored to some extent in EEG signals from multiple users watching the same emotional video clips at the same time. Interestingly, emotions decoding performances were increased by using the EEG data from several users compared to using EEG from each individual user [33].

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Grants with Industry

Ullo:

Duration: 2017-2019

Local coordinator: Martin Hachet

Following our work with the Introspectibles (Teegi, TOBE, Inner Garden), we are currently working with the ULLO company to bring these new interfaces to healthcare centers.

9. Partnerships and Cooperations

9.1. Regional Initiatives

HOBIT:

Funding: Aquitaine Science Transfer

Duration: 2018

Local coordinator: Martin Hachet

Partners: Université de Bordeaux

We are currently moving our platform HOBIT from his lab state to a commercial product.

Erlen:

Funding: Université de Bordeaux - Hacketafac program

Duration: 2018-2019

Local coordinator: Pierre-Antoine Cinquin

We won a grant from Université de Bordeaux to explore awareness of power consumption by way of tangible and ambient interfaces.

Neuroperf:

Funding: Idex Université Bordeaux

Duration: 2017-2019

Coordinator: Jean-Arthur Micoulaud Franci

Local coordinator: Fabien Lotte

Partners: SANPSY - Potioc

This project aims at studying EEG-based Neurofeedback to reduce fatigue symptoms in sleep-deprived individuals. See http://brain.labex.u-bordeaux.fr/Actualites/Selection-projets-recherche-Clinique-2017-i5064.html

9.2. National Initiatives

eTAC: Tangible and Augmented Interfaces for Collaborative Learning:

Funding: EFRAN

Duration: 2017-2021

Coordinator: Université de Lorraine

Local coordinator: Martin Hachet

Partners: Université de Lorraine, Inria, ESPE, Canopé, OpenEdge,

the e-TAC project proposes to investigate the potential of technologies ”beyond the mouse” in order to promote collaborative learning in a school context. In particular, we will explore augmented reality and tangible interfaces, which supports active learning and favors social interaction.

ANR Rebel:

Duration: 2016-2019

Coordinator: Fabien Lotte

Funding: ANR Jeune Chercheur Jeune Chercheuse Project

Partners: Disabilities and Nervous Systems Laboratory Bordeaux

Brain-Computer Interfaces (BCI) are communication systems that enable their users to send commands to computers through brain activity only. While BCI are very promising for assistive technologies or human-computer interaction (HCI), they are barely used outside laboratories, due to a poor reliability. Designing a BCI requires 1) its user to learn to produce distinct brain activity patterns and 2) the machine to recognize these patterns using signal processing. Most research efforts focused on signal processing. However, BCI user training is as essential but is only scarcely studied and based on heuristics that do not satisfy human learning principles. Thus, currently poor BCI reliability is probably due to suboptimal user training. Thus, we propose to create a new generation of BCI that apply human learning principles in their design to ensure the users can learn high quality control skills, hence making BCI reliable. This could change HCI as BCI have promised but failed to do so far.

Inria Project Lab BCI-LIFT:

Duration: 2015-2018

Partners: Inria team Athena (Inria Sophia-Antipolis), Inria team Hybrid (Inria Rennes), Inria team Neurosys (Inria Nancy), LITIS (Université de Rouen), Inria team DEMAR (Inria Sophia-Antipolis), Inria team MINT (Inria Lille), DyCOG (INSERM Lyon)

Coordinator: Maureen Clerc (Inria Sophia Antipolis)

Local coordinator: Fabien Lotte

The aim is to reach a next generation of non-invasive Brain-Computer Interfaces (BCI), more specifically BCI that are easier to appropriate, more efficient, and suit a larger number of people. With this concern of usability as our driving objective, we will build non-invasive systems that benefit from advanced signal processing and machine learning methods, from smart interface design, and where the user immediately receives supportive feedback. What drives this project is the concern that a substantial proportion of human participants is currently categorized "BCI-illiterate" because of their apparent inability to communicate through BCI. Through this project we aim at making it easier for people to learn to use the BCI, by implementing appropriate machine learning methods and developping user training scenarios.

website: http://bci-lift.inria.fr/

Inria Project Lab AVATAR:

Duration: 2018-2022

Partners: Inria project-teams: GraphDeco, Hybrid, Loki, MimeTIC, Morpheo

Coordinator: Ludovic Hoyet (Inria Rennes)

Local coordinator: Martin Hachet

This project aims at designing avatars (i.e., the user's representation in virtual environments) that are better embodied, more interactive and more social, through improving all the pipeline related to avatars, from acquisition and simulation, to designing novel interaction paradigms and multi-sensory feedback.

website: https://avatar.inria.fr

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

BrainConquest:

Program: ERC Starting Grant

Project title: BrainConquest - Boosting Brain-Computer Communication with High Quality User Training

Duration: 2017-2022

Coordinator: Fabien Lotte

Abstract: Brain-Computer Interfaces (BCIs) are communication systems that enable users to send commands to computers through brain signals only, by measuring and processing these signals. Making computer control possible without any physical activity, BCIs have promised to revolutionize many application areas, notably assistive technologies, e.g., for wheelchair control, and man-machine interaction. Despite this promising potential, BCIs are still barely used outside laboratories, due to their current poor reliability. For instance, BCIs only using two imagined hand movements as mental commands decode, on average, less than 80% of these commands correctly, while 10 to 30% of users cannot control a BCI at all. A BCI should be considered a co-adaptive communication

system: its users learn to encode commands in their brain signals (with mental imagery) that the machine learns to decode using signal processing. Most research efforts so far have been dedicated to decoding the commands. However, BCI control is a skill that users have to learn too. Unfortunately how BCI users learn to encode the commands is essential but is barely studied, i.e., fundamental knowledge about how users learn BCI control is lacking. Moreover standard training approaches are only based on heuristics, without satisfying human learning principles. Thus, poor BCI reliability is probably largely due to highly suboptimal user training. In order to obtain a truly reliable BCI we need to completely redefine user training approaches. To do so, I propose to study and statistically model how users learn to encode BCI commands. Then, based on human learning principles and this model, I propose to create a new generation of BCIs which ensure that users learn how to successfully encode commands with high signal-to-noise ratio in their brain signals, hence making BCIs dramatically more reliable. Such a reliable BCI could positively change man-machine interaction as BCIs have promised but failed to do so far.

9.3.2. Collaborations in European Programs, Except FP7 & H2020

VISTE:

Program: Erasmus + Key Action 2: Cooperation for Innovation and Exchange of Good Practices

Project title: VISTE: Empowering spatial thinking of students with visual impairment

Duration: 01/09/2016 - 31/08/2019

Coordinator: Professor Marinos Kavouras (Vice-Rector, National Technical University of Athens and VISTE Project Leader)

Partners: National Technical University of Athens, Inria, Intrasoft International S.A., Casa Corpului Didactic Cluj, Eidiko Dimotiko Sxolio Tiflon Kallitheas, Liceul Special pentru Deficienti de Vedere Cluj-Napoca. External collaborators : IRSA, RealityTech

Abstract: Six partners from four European countries are working together to develop strategies, educational components and an ICT toolkit towards effective spatial thinking of students with VI, facilitating inclusion. The competence of spatial thinking, usage and interpretation of maps or other spatial tools is not self-evident for all; it is a dexterity which must be cultivated. For students experiencing disabilities, such as visual impairment (VI), spatial thinking proves to be an imperative skill for perceiving the world far beyond their immediate experience. Learning functional ways to utilize spatial experiences as an entirety and realize the relationships between objects in space and themselves is vital. Maps and other spatial representations are a splendid source of information for portraying space and environment. By using tactile maps and innovative ICT technologies, children may deploy their spatial notion more effectively compared to proximate orientation experiences in accordance with verbal directions. Providing thus a concrete set of such tools would empower specific spatial thinking skills not only of those with VI but of all students. VISTE aims at empowering the spatial thinking skills of students with VI. This will be accomplished by providing an innovative methodological framework and a semantic and technical infrastructure for developing appropriate inclusive educational modules to foster spatial thinking. The project's main target groups are primary/secondary education students, as well as teachers, teachers' trainers, and staff involved in their education.

RSVP-BCI:

Program: DGA-DSTL Project

Project title: Assessing and Optimising Human-Machine Symbiosis through Neural signals for Big Data Analytics

Duration: 2014-2018

Coordinator: Damien Coyle and Fabien Lotte

Partners: Ulster University, UK, Potioc, France

Abstract: This project objective is to design new tools for Big Data analysis, and in particular visual analytics tools that tap onto human cognitive skills as well as on Brain-Computer Interfaces. The goal is to enable the user to identify and select relevant information much faster than what can be achieved by using automatic tools or traditional human-computer interfaces. More specifically, this project will aim at identifying in a passive way various mental states (e.g., different kinds of attention, mental workload, relevant stimulus perception, etc.) in order to optimize the display, the arrangement of the selection of relevant information.

9.3.3. Collaborations with Major European Organizations

Partner 1: Univ. Freiburg (Germany)

EEG signal processing and decoding using robust methods

Partner 2: TU Berlin (Germany)

EEG data generation and simulation

9.4. International Initiatives

9.4.1. Inria International Partners

9.4.1.1. Informal International Partners

Partner: RIKEN Brain Science Institute, Japan

Topic: BCI, Neurofeedback and EEG signal decoding

9.4.2. Participation in Other International Programs

Partner: University of Waterloo, Canada

Program: Idex Bordeaux collaboration grant

Duration: 2018

Coordinators: Edith Law (Canada), Pierre-Yves Oudeyer (France)

Topic: Curiosity

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Internships

- Marie Gonzales, Universidad Chile
- Mehdi Bugallo, University of Minho, Portugal
- Satyam Kumar, IIT Kanpur, India

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- RIKEN Brain Science Institute, Japan (Fabien Lotte)

10. Dissemination

10.1. Promoting Scientific Activities

10.1.1. Scientific Events Organisation

10.1.1.1. General Chair, Scientific Chair

- EduIHM 2018 (workshop at IHM 2018), Martin Hachet

- 5th Sino-French Workshop on Virtual reality (Chengdu, August 2018), Pascal Guitton
- 3rd International OpenViBE workshop, IEEE SMC 2018, (Miyazaki, Japan, October 2018), Fabien Lotte
- Workshop “Turning negative into positives! Exploiting “negative” results in Brain-Machine Interface research”, International BCI Meeting 2018, Asilomar, CA, USA, Fabien Lotte

10.1.1.2. Member of the Organizing Committees

- Workshop VR/AR in BCI, BCI Meeting Asilomar, USA, May 2018, Jelena Mladenovic
- Workshop“Collaborative and Competing Multi-Brain BCI‘s”, International BCI Meeting 2018, Asilomar, CA, USA, Fabien Lotte
- "3ème journée Nationale sur le neurofeedback : a forward step towards closed loop", Lyon, France, May 2018, Fabien Lotte
- Game Accessibility Conference EU 18, CNAM, Paris, October 2018, Pierre-Antoine Cinquin

10.1.2. Scientific Events Selection

10.1.2.1. Member of the Conference Program Committees

- Cyberworlds 2018, Fabien Lotte
- IEEE Conference on Systems, Man and Cybernetics, Brain-Machine Interface Workshop (IEEE SMC) 2018, Fabien Lotte
- International Workshop on Pattern Recognition in NeuroImaging (PRNI) 2018, Fabien Lotte
- International Neuroergonomics Conference 2018 (Fabien Lotte)
- International BCI Meeting 2018, Fabien Lotte
- Augmented Human Conference (AH), 2018, Fabien Lotte

10.1.2.2. Reviewer

- ACM CHI 2018 and 2019
- ACM UIST 2018
- ACM MobileHCI 2018
- ACM IDC 2018
- ACM CHI Play 2018
- IEEE VR 2018
- 4th IEEE VR 3DCVE Workshop 2018
- IEEE SMC 2018
- ICMI 2018
- MCPMD Workshop, ICMI 2018
- Augmented Human 2018
- MobileCHI 2018
- ICASSP 2018
- Int. BCI Meeting 2018
- JJC-ICON 2018
- Neuroergonomics 2018
- PRNI 2018
- Cyberworlds 2018
- NIPS 2018
- Games User Research EU Conference 2018
- Conférence ISCRAM 2019

10.1.3. Journal

10.1.3.1. Member of the Editorial Boards

- IEEE Computer Graphics and Applications, Martin Hachet
- Journal of Neural Engineering, Fabien Lotte
- Brain-Computer Interfaces, Fabien Lotte

10.1.3.2. Reviewer - Reviewing Activities

- Plos One
- Journal of Neural Engineering
- Computational Intelligence and Neuroscience
- Cognitive Computation
- Frontiers in Neuroscience
- IEEE Signal Processing Letters
- IEEE TVCG
- IEEE TBME
- IEEE Trans. Games
- IEEE TNSRE
- IEEE CGA
- IJHCS
- ACM TOCHI
- ACM TACCESS
- Springer Nature Scientific Reports

10.1.4. Invited Talks

- "Comment rendre accessible les enseignements en ligne comme les MOOC pour des étudiants en situation de handicap", Colloque Sensibilisation et regards croisés autour du handicap, 18-19 janvier 2018, Bordeaux, Pascal Guitton
- "Défis et opportunités pour l'Accessibilité numérique", 20ème anniversaire BrailleNet, 14 juin 2018, Issy les moulineaux, Pascal Guitton
- "Accessibilité numérique des systèmes d'enseignement en ligne pour des personnes en situation de handicap d'origine cognitif", 2ième Journée scientifique du centre d'excellence BIND (CHU & Université de Bordeaux) "Innovation technologique et maladies neurodégénératives", 23 novembre 2018, Bordeaux, Pascal Guitton
- "Measuring Intrinsic motivation/curiosity through Electroencephalography", UQAM Psychology Lab Montreal, Canada, Aurélien Appriou
- "Endowing the Machine with Active Inference in a P300 BCI", Seminar of Computational Neuroscience, Inria Bordeaux, November 2018, Jelena Mladenovic
- "Combining physiological sensing and User modeling for intuitive HCI at Intelligent User Interfaces: Eye Tracking and Beyond", Workshop in Haifa University, Israel, April 2018, Jelena Mladenovic
- "Taxonomy for Adaptive BCI: User and Task Modeling at Brain-computer communication: Towards real world applications", BCI Conference in IDC Herzlyia, Israel, March 2018, Jelena Mladenovic
- "Learning to control Mental Imagery-based Brain-Computer Interfaces", Journées Scientifiques Inria, Bordeaux, France, June 2018, Fabien Lotte,
- "L'interaction Cerveau-Ordinateur", Pause de l'institut des études avancées de l'université de Bordeaux, Cadillac, France, June 2018, Fabien Lotte

- "Models and tools to design non-invasive Brain-Computer Interfaces", Neurocampus annual meeting day, Bordeaux, May 2018, Fabien Lotte
- "Understanding and Redefining User Training to Mental Imagery-based Brain-Computer Interfaces Control", Laboratoire d'Étude des Mécanismes Cognitifs (EMC), Lyon, France, April 2018, Fabien Lotte
- "Redefining user training in BCI/Neurofeedback by combining machine learning, neuroscience and psychology", 2018 RIKEN-BSI-Cichocki Laboratory Alumni Japan Workshop on Frontier of Multidisciplinary Research: Brain Signal Processing and Multiway Data Mining Wakoshi, Saitama, Japan, March, 2018, Fabien Lotte
- "Learning for BCI and BCI for Learning", BCI Symposium "Brain-computer communication: Towards real world applications", Tel Aviv, Israel, March 2018, Fabien Lotte
- "Redefining User Training in Mental Imagery-based Brain-Computer Interfaces", ESPCI, Paris, February 2018, Fabien Lotte
- Présentation des travaux avec l'IRSA, 39ième congrès de la FISAF, Lauren Thevin

10.1.5. Scientific Expertise

- Expert for "Credit Impot Recherche", Martin Hachet
- Expert for the ANR, Committee CES33 "Interaction, Robotics and IA", Fabien Lotte

10.1.6. Research Administration

- Member of "Bureau du comite des projets", Martin Hachet
- Member of "Conseil administration de l'AFIHM", Martin Hachet
- Member of scientific committee of SCRIME, Martin Hachet
- Elected member of the board of the French BCI society (CORTICO), Fabien Lotte
- Representative of Inria for NEM, Fabien Lotte
- Member of Commission de recrutement des Inspecteurs Généraux de l'Education Nationale (IGEN), Pascal Guitton
- Responsable of Inria Cellule de veille et de prospective, Pascal Guitton
- Member of Inria Ethical Committee (COERLE), Pascal Guitton
- Member of Inria Comité Parité et Egalité, Pascal Guitton
- Responsable of Inria RA2020 Committee (new annual Activity Report), Pascal Guitton
- Member of Inria International Chairs Committee, Pascal Guitton

10.2. Teaching - Supervision - Juries

10.2.1. Teaching

- Master: Martin Hachet, Réalité Virtuelle, 12h eqTD, M2 Cognitive science, Université de Bordeaux
- Master : Philippe Giraudeau, Handicap et Nouvelles technologies, 9h eqTD, M2 Cognitive science, Université de Bordeaux
- Master: Martin Hachet, Réalités Virtuelles et augmentées, 18h eqTD, M2 Computer science, Université de Bordeaux
- Master: Rajkumar Darbar, Réalités Virtuelles et augmentées, 18h eqTD, M2 Computer science, Université de Bordeaux
- Master: Pierre-Antoine Cinquin, Assistive technologies, CM-TD, 15h eqTD, M2 Cognitive Science, Université de Bordeaux
- Master: Léa Pillette, Handicap, Autonomy and cognition, 5h eqTD, M2 Cognitive science, University of Bordeaux

- Master: Fabien Lotte, Réalités Virtuelles et augmentées, 7h eqTD, M2 Computer science, Université de Bordeaux
- Master: Fabien Lotte, Réalité Virtuelle, 5h eqTD, M2 Cognitive science, Université de Bordeaux
- Master: Pascal Guitton, Digital accessibility, CM, 18h eqTD, M1 Cognitive science, University of Bordeaux
- Bachelor: Aurélien Appriou, Knowledge and Representation, 13.5h eqTD, 3rd year BD MIASHS: Cognitive science
- Bachelor: Aurélien Appriou, Knowledge and Representation, 14h eqTD, 3rd year BD MIASHS: Cognitive science
- Bachelor, Aurélien Appriou, Langugages and Mind, 20h eqTD, 3rd year BD MIASHS: Cognitive science
- Bachelor: Lauren Thevin, Culture et Compétences Numériques, Pix (nouveau C2I), 10h eqTD, 1st year, Université de Bordeaux
- IUT : Philippe Giraudeau, Algorithme et programmation, 24h eqTD, 1st year IUT, Université de Bordeaux
- Engineering school: Camille Benaroch, Advanced mathematics and computer science, 61.5h eqTD, 2nd year, ENSAM, Bordeaux
- Engineering school: Martin Hachet, Ergonomie et Interaction, 15h eqTD, 3rd year, ENSEIRB, INP
- Engineering school: Léa Pillette, Knowledge and Representations, 36h eqTD, 1st year, ENSC, INP
- Engineering school: Léa Pillette, IT projects, 8h eqTD, 2nd year, ENSC, INP, Bordeaux
- Engineering school: Lauren Thevin, Intelligence Artificielle, 15h eqTD, 2nd year, ENSC, INP, Bordeaux
- Engineering school: Pierre-Antoine Cinquin, Video Game Accessibility, TD, 18h eqTD, M2 JMIN and STMN, CNAM ENJMIN, Angoulême
- MOOC : Pascal Guitton, Accessibilité numérique, 5 weeks, Plateforme FUN, 3rd session

10.2.2. Supervision

- PhD in progress: Rajkumar Darbar, Actuated Tangible User Interfaces, 1/12/2017, Martin Hachet
- PhD in progress: Philippe Giraudeau, Collaborative learning with tangible and aumented interfaces, 1/10/2017, Martin Hachet
- PhD in progress: Marc Baloup, Interaction with Avatars, 1/10/2018, Martin Hachet (33%)
- PhD in progress: Pierre-Antoine Cinquin, Design and Experimental Validation of Accessible E-learning systems for people with cognitive disabilities, since Sept. 2016, Pascal Guitton (50%)
- PhD in progress: Jelena Mladenovic, User modeling for Adaptive BCI design, 1/1/2016, Fabien Lotte (50%)
- PhD in progress: Léa Pillette, Formative feedback for BCI, 1/10/2016, Fabien Lotte (50%)
- PhD in progress: Aurélien Appriou, Estimating learning-related mental states in EEG, 1/10/2017, Fabien Lotte
- PhD in progress: Camille Benaroch, Computational Modeling of BCI user training, 1/10/2018, Fabien Lotte (50%)

10.2.3. Juries

- PhD: Guillaume Cortes [with report], Univ. Rennes, Martin Hachet
- PhD: Alexandra Delmas, Univ. Bordeaux, Martin Hachet
- PhD: Adrien Verhulst, Centrale Nantes, Pascal Guitton
- PhD: Anne-Solène Dris [with report], INSA Rennes, Pascal Guitton

- PhD: Mark Parent [with report], Univ. Laval, Quebec, Canada, Fabien Lotte
- PhD: Ayoub Hajlaoui [with report], Université Pierre et Marie Curie and Telecom Paris, France, Fabien Lotte
- Benjamin Wittevrongel [with report], KU Leuven, Belgium, Fabien Lotte
- PhD: Benjamin Clément, Univ. Bordeaux, France, Fabien Lotte
- PhD: Bertille Somon, Univ. Grenobles Alpes, France, Fabien Lotte
- PhD: Aldo Mora, ESPCI, Paris, France, Fabien Lotte
- HdR: Antonio Capobianco [with report], Univ. Strasbourg, Pascal Guitton
- HdR: Patrick Reuter, Univ. Bordeaux, Pascal Guitton

10.3. Popularization

10.3.1. Internal or external Inria responsibilities

- Member of editorial Board of Blog Binaire - Le Monde, Pascal Guitton

10.3.2. Articles and contents

- Martin Hachet, *Art et Informatique: Fertilisation croisée*, Blog Binaire - Le Monde, [46]
- Pascal Guitton, *L'accessibilité numérique, pourquoi il faut la développer*, Blog Binaire - Le Monde, [45]
- Bruno Arnaldi, Pascal Guitton & Guillaume Moreau, *Rendez-vous dans 10 ans*, Blog Binaire - Le Monde, [44]

10.3.3. Education

- Potioc booth at EdTech days, Bordeaux, May 18
- "Pensez-vous qu'il soit possible de lire dans les pensées?", Scientific debate to launch the "projets indisciplinés" of University of Bordeaux, October 2018, Fabien Lotte
- "La recherche sur les interfaces cerveau-ordinateur chez Potioc", Presentation for Bachelor 3, ENS Lyon, visiting Inria Bordeaux, December 2018, Fabien Lotte
- "Le futur des interfaces : interfaces invisibles", Master Class Festival Futur.e.s, Lauren Thevin
- Booth at Laval Virtual (Espace Révolution)

10.3.4. Interventions

- Pint of Science, Bordeaux, May 18, Martin Hachet and Philippe Giraudeau
- Cinema Sciences, Merignac, April 18, Martin Hachet
- Goûter des sciences / Les petits débrouillards (Figure 9), Bordeaux, December 18, Martin Hachet, Philippe Giraudeau, Théo Segonds, Nicolas Palard
- Organization of a workshop for middle and high school students, Ethnography museum, University of Bordeaux, 8-11th Oct. 2018, Léa Pillette
- "Optimizing humans digital learning by decoding brain activity in real time", Poster, ESOF Toulouse, France, July 2018, Aurélien Appriou
- "Flow theory for optimizing BCI", CogTalk, Bordeaux, November 2018, Jelena Mladenovic
- "Cerveau et jeux vidéo", CogTalk, Bordeaux, March 2018, Pierre-Antoine Cinquin
- L'accessibilité des jeux vidéo, Masterclass Scientific Game Jam, March 2018, Université de Bordeaux
- Seminar for PhD students – Flow theory for optimizing BCI, ISPED Bordeaux, November 2018, Jelena Mladenovic
- "Contrôler un ordinateur par l'activité cérébrale : Mythe ou Réalité ?", Conférence grand public de restitution des pauses de l'institut des études avancées de l'université de Bordeaux, Talence, June 2018, Fabien Lotte
- "Les Interfaces Cerveau-Ordinateur : Progrès et questions", Centre Culturel du Hâ, Bordeaux, France, May 2018, Fabien Lotte
- "Mixed reality for visual impaired people", Cherchons pour Voir & IJA (Institut des Jeunes Aveugles, Toulouse), Apéro Sciences, Lauren Thévin
- "Accessibilité numérique : pourquoi et comment", Inria Tech Talk, Station F, Paris, Pascal Guitton

Figure 9. The Potioc team at Gouter des Sciences / les petits débrouillards, Dec. 18.

10.3.5. Internal action

- Unithé ou Café, Martin Hachet, May 18
- Potioc Demos for 10th anniversary of Inria Bordeaux, Sept. 18
- Fete de la sciences, Demo at CapSciences, Oct. 18.

11. Bibliography

Major publications by the team in recent years

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[2] J. FREY, R. GERVAIS, S. FLECK, F. LOTTE, M. HACHET. *Teegi: Tangible EEG Interface*, in "UIST-ACM User Interface Software and Technology Symposium", Honolulu, United States, ACM, October 2014, https://hal.inria.fr/hal-01025621

[3] D. FURIO, S. FLECK, B. BOUSQUET, J.-P. GUILLET, L. CANIONI, M. HACHET. *HOBIT: Hybrid Optical Bench for Innovative Teaching*, in "CHI'17 - Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems", Denver, United States, May 2017 [*DOI :* 10.1145/3025453.3025789], https://hal.inria.fr/hal-01455510

[4] M. HACHET, J.-B. DE LA RIVIÈRE, J. LAVIOLE, A. COHÉ, S. CURSAN. *Touch-Based Interfaces for Interacting with 3D Content in Public Exhibitions*, in "IEEE Computer Graphics and Applications", March 2013, vol. 33, n^{O} 2, pp. 80-85 [*DOI :* 10.1109/MCG.2013.34], http://hal.inria.fr/hal-00789500

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[8] F. LOTTE, F. LARRUE, C. MÜHL. *Flaws in current human training protocols for spontaneous Brain-Computer Interfaces: lessons learned from instructional design*, in "Frontiers in Human Neurosciences", September 2013, vol. 7, n^{o} 568 [*DOI :* 10.3389/FNHUM.2013.00568], http://hal.inria.fr/hal-00862716

[9] J. SOL ROO, R. GERVAIS, J. FREY, M. HACHET. *Inner Garden: Connecting Inner States to a Mixed Reality Sandbox for Mindfulness*, in "CHI '17 - International Conference of Human-Computer Interaction", Denver, United States, CHI '17, ACM, May 2017 [*DOI :* 10.1145/3025453.3025743], https://hal.archives-ouvertes.fr/hal-01455174

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Publications of the year

Articles in International Peer-Reviewed Journals

[11] P.-A. CINQUIN, P. GUITTON, H. SAUZÉON. *Online e-learning and cognitive disabilities: A systematic review*, in "Computers and Education", March 2019, vol. 130, pp. 152-167, https://hal.archives-ouvertes.fr/hal-01954983

[12] C. JEUNET, F. LOTTE, J.-M. BATAIL, P. PHILIP, J.-A. MICOULAUD-FRANCHI. *Using recent BCI literature to deepen our understanding of clinical neurofeedback: A short review*, in "Neuroscience", May 2018, vol. 378, pp. 225-233 [*DOI :* 10.1016/J.NEUROSCIENCE.2018.03.013], https://hal.inria.fr/hal-01728767

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