Activity Report 2017

Project-Team PHOENIX

Programming Language Technology For Communication Services

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Project-Team PHOENIX

Creation of the Project-Team: 2005 September 08, end of the Project-Team: 2017 December 31

Keywords:

Computer Science and Digital Science:

A1.2.5. - Internet of things
A1.4. - Ubiquitous Systems
A2.1. - Programming Languages
A2.4.2. - Model-checking
A2.5. - Software engineering
A2.6.2. - Middleware
A5.1. - Human-Computer Interaction
A5.11. - Smart spaces

Other Research Topics and Application Domains:

B1.2.2. - Cognitive science
B2.1. - Well being
B2.5.2. - Cognitive disabilities
B2.5.3. - Assistance for elderly
B4.5. - Energy consumption
B8. - Smart Cities and Territories

1. Personnel

Research Scientists

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Julien Durand [Inria, until Oct 2017]
Leo Mendiboure [Inria, from Oct 2017]
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2. Overall Objectives

2.1. Context

A host of networked entities (devices and services) are populating smart spaces that become prevalent (*e.g.,*, building management, personal assistance, avionics) and large scale (*e.g.,*, train station, city, highway network). These smart spaces are becoming intimately intertwined with our daily life and professional activities, raising scientific challenges that go beyond the boundaries of single field of expertise.

2.2. A Multi-Disciplinary Approach

We focus our attention on the domain of applications that orchestrate networked objects, whether populating smart spaces or worn by individuals on-the-go. Because such applications are intimately intertwined with the users' daily life and professional activities, they can improve users' efficiency in performing tasks or compensate for the users' deficiencies and disabilities, promoting autonomy. However, this emerging domain of *assistive computing* raises scientific challenges that go beyond the boundaries of Computer Science. To address these challenges, the Phoenix group has been conducting interdisciplinary research that combines

- Cognitive Science to study user needs and make a rigorous assessment of the services provided to users;

- Sensing and actuating expertise to support users, based on accurate and rich interactions with their environment;

- Design-driven software engineering to support and guide all the development process of the services provided to users.

2.3. Research Avenues

The activities of the Phoenix group revolve around three main avenues of research.

Design-driven software development. We further the study of design-driven software development, exploring the integration of both functional and non-functional concerns in the design phase, as well as the human-computer interaction dimension. We also expand the scope of our approach by scaling it up to the orchestration of masses of sensors and actuators.

Assistive computing in the home. This line of work leverages DiaSuite to develop an assisted living platform, named HomeAssist, which exploits the capabilities of smart spaces to provide services that compensate or remediate cognitive difficulties of users, drawn from needs analyses. This work is validated in the context of two research projects: HomeAssist for older adults, and ANDDI for adults with Intellectual Disabilities (ID). This platform is currently deployed in the homes of older adults where a variety of applications assist them with their daily activities.

Assistive computing on-the-go. We develop mobile assistive computing support based on tablets. In particular, we have developed a cognitive assistive technology for the inclusion of children with Autism in mainstreamed environments, named School+.

3. Research Program

3.1. Design-Driven Software Development

Raising the level of abstraction beyond programming is a very active research topic involving a range of areas, including software engineering, programming languages and formal verification. The challenge is to allow design dimensions of a software system, both functional and non-functional, to be expressed in a high-level way, instead of being encoded with a programming language. Such design dimensions can then be leveraged to verify conformance properties and to generate programming support.

Our research on this topic is to take up this challenge with an approach inspired by programming languages, introducing a full-fledged language for designing software systems and processing design descriptions both for verification and code generation purposes. Our approach is also DSL-inspired in that it defines a conceptual framework to guide software development. Lastly, to make our approach practical to software developers, we introduce a methodology and a suite of tools covering the development life-cycle.

To raise the level of abstraction beyond programming, the key approaches are model-driven engineering and architecture description languages. A number of *architecture description languages* have been proposed; they are either (1) coupled with a programming language (*e.g.,* [25]), providing some level of abstraction above programming, or (2) integrated into a programming language (*e.g.,* [21], [26]), mixing levels of abstraction. Furthermore, these approaches poorly leverage architecture descriptions to support programming, they are crudely integrated into existing development environments, or they are solely used for verification purposes. *Model-driven software development* is another actively researched area. This approach often lacks code generation and verification support. Finally, most (if not all) approaches related to our research goal are *general purpose*; their universal nature provides little, if any, guidance to design a software system. This situation is a major impediment to both reasoning about a design artifact and generating programming support.

3.2. Integrating Non-Functional Concerns into Software Design

Most existing design approaches do not address non-functional concerns. When they do, they do not provide an approach to non-functional concerns that covers the entire development life-cycle. Furthermore, they usually are general purpose, impeding the use of non-functional declarations for verification and code generation. For example, the Architecture Analysis & Design Language (AADL) is a standard dedicated to real-time embedded systems [22]. AADL provides language constructs for the specification of software systems (*e.g.,* component, port) and their deployment on execution platforms (*e.g.,* thread, process, memory). Using AADL, designers specify non-functional aspects by adding properties on language constructs (*e.g.,* the period of a thread) or using language extensions such as the Error Model Annex. [1] The software design concepts of AADL are still rather general purpose and give little guidance to the designer.

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[1]The Error Model Annex is a standardized AADL extension for the description of errors [27].

Beyond offering a conceptual framework, our language-based approach provides an ideal setting to address non-functional properties (*e.g.,* performance, reliability, security, ...). Specifically, a design language can be enriched with non-functional declarations to pursue three goals: (1) expanding further the type of conformance that can be checked between the design of a software system and its implementation or execution infrastructure, (2) enabling additional programming support and guidance, and (3) leveraging the design declarations to optimize the generated implementation.

We are investigating this idea by extending our design language with non-functional declarations. For example, we have addressed error handling [9], access conflicts to resources [24], quality of service constraints [23], and more recently, data delivery models and parallel computation models for masses of sensors [14].

Following our approach to paradigm-oriented software development, non-functional declarations are verified at design time, they generate support that guides and constrains programming, they produce a runtime system that preserves invariants and performs efficiently.

3.3. Human-Driven Software Design

Knowledge of the human characteristics (individual, social and organizational) allow the design of complex system and artifacts for increasing their efficacy. In our approach of assistive computing, a main challenge is the integration of facets of Human Factors in order to design technology support adapted to user needs in term of ergonomic properties (acceptability, usability, utility etc) and delivered functionalities (oriented task under user abilities contraints).

We adapt this approach to improve the independent living and self-determination of users with cognitive impairments by developing a variety of orchestration scenarios of networked objects (hardware/software) to provide a pervasive support to their activities. Human factors methodologies are adopted in our approach with as direct purpose the reliability and efficiency of the performance of digital support systems in respect of objectives of health and well-being of the person (monitoring, evaluation, and rehabilitation).

Precisely, our methodologies are based on a closed iterative loop, as described in the figure below :

- Identifying the person needs in a natural situation (*i.e.,* desired but problematic activities) according to Human Factors Models of activity (*i.e.,* environmental constraints; social support networks - caregivers and family; person's abilities)

- Designing environmental support that will assist the users to bypass their cognitive impairment (according to environmental models of cognitive compensatory mechanisms); and then implement this support in terms of technological solutions (scenarios of networked objects, hardware interface, software interface, interaction style, *etc*)

- Empirically evaluating the assistive solution based on human experimentations that includes ergonomic assessments (acceptability, usability, usefulness, *etc*) as well as longitudinal evaluations of use's efficacy in terms of activities performed by the individual, of satisfaction and well-being provided to the individual but also to his/her entourage (family and caregivers).

4. Application Domains

4.1. Internet of Things

Participants: Charles Consel, Nic Volanschi.

The Internet of Things (IoT) has become a reality with the emergence of Smart Cities, populated with large amounts of smart objects which are used to deliver a range of citizen services (e.g., security, well being, etc.) The IoT paradigm relies on the pervasive presence of smart objects or "things", which raises a number of new challenges in the software engineering domain.

User-Centered Approach

Diagnostic

- **User**
  - Cognitive resources
  - Sensorimotor abilities
  - Technological abilities
  - Preferences
- **Environment**
  - Home environment
  - Social environment
  - Care environment
- **Occupation**
  - Functional assessment (ADLs, IADLs)

Assistance

- **Type of support**
  - Task supervision
  - Social interaction
  - Gaming
  - Organization
  - Task prompting
- **Assistive application**
  - Selection
  - Cuing type
  - Cuing level

Evaluation

- **Evaluation criteria**
  - General purpose
  - Support-type specific
- **Participants**
  - User
  - Caregiver – informal
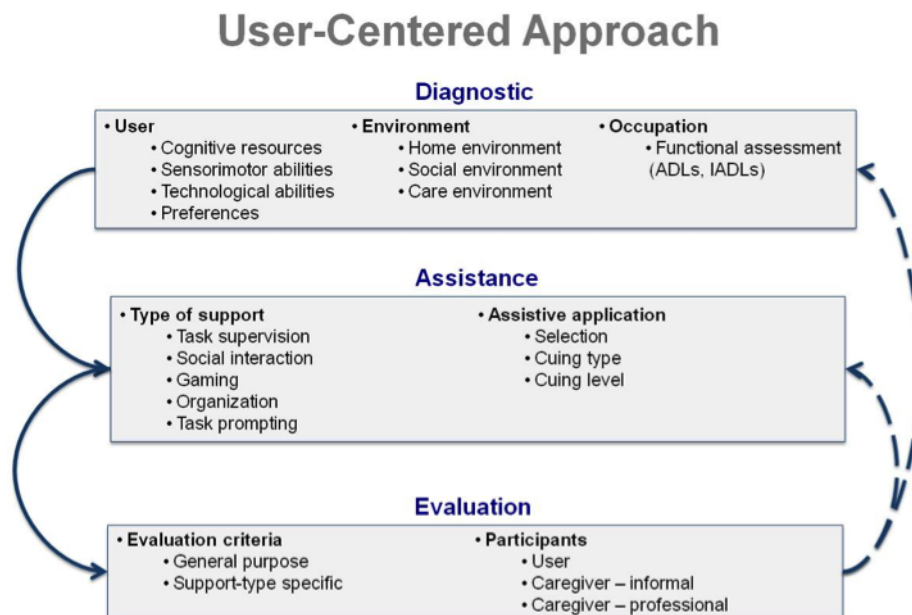 - Caregiver – professional

Figure 1. User-Centered Approach

We introduce a design-driven development approach that is dedicated to the domain of orchestration of masses of sensors. The developer declares what an application does using a domain-specific language (DSL), named DiaSwarm. Our compiler processes domain-specific declarations to generate a customized programming framework that guides and supports the programming phase.

DiaSwarm addresses the main phases of an application orchestrating masses of sensors.

Service discovery Standard service discovery at the individual object level does not address the needs of applications orchestrating large numbers of smart objects. Instead, a high-level approach which provides constructs to specifying subsets of interest is needed. Our approach allows developers to introduce application-specific concepts (e.g., regrouping parking spaces into lots or districts) at the design time and then these can be used to express discovery operations. Following our design-driven development approach, these concepts are used to generate code to support and guide the programming phase.

Data gathering Applications need to acquire data from a large number of objects through a variety of delivery models. For instance, air pollution sensors across a city may only push data to the relevant applications when pollution levels exceed tolerated levels. Tracking sensors, however, might determine the location of vehicles and send the acquired measurements to applications periodically (e.g., 10 min. intervals). Data delivery models need to be introduced at design time since they have a direct impact on the application's program structure. In doing so, the delivery models used by an application can be checked against sensor features early in the development process.

Data processing Data that is generated from hundreds of thousands of objects and accumulated over a period of time calls for efficient processing strategies to ensure the required performance is attained. Our approach allows for an efficient implementation of the data processing stage by providing the developer with a framework based on the MapReduce [34] programming model which is intended for the processing of large data sets.

4.2. Assistive computing in the home

Participants: Quentin Barlas, Antoine Riche, Adrien Carteron, Rafik Belloum, Audrey Landuran, Julien Durand, Charlotte Froger, Stéphanie Giraud, Pauline Fontagne, Flora Gallet, Amandine Desrozier, Ludovic Fornasari, Léo Mendiboure, Hélène Sauzéon, Charles Consel, Bernard N'Kaoua, Bernard Serpette, Nic Volanschi.

In this avenue of research, we have been developing a systemic approach to introducing an assisted living platform for the home of older adults. To do so, we formed an interdisciplinary team that allows (1) to identify the user needs from a gerontological and psychological viewpoint; (2) to propose assistive applications designed by human factors and HCI experts, in collaboration with caregivers and users; (3) to develop and test applications designed and developed by software engineers; (4) to conduct a field study to assess the benefits of the platform and assistive applications, in collaboration with caregivers, by deploying the system at the actual homes.

Our research activities for assistive computing in the home are conducted under the *HomeAssist* project. This work takes the form of a platform offering an online catalog of assistive applications that orchestrate an open-ended set of networked objects. Our platform leverages DiaSuite to quickly and safely develop applications at a high level.

Our scientific achievements include the design principles of our platform, its key features to effectively assist individuals in their home, field studies to validate HomeAssist, the expansion of HomeAssist to serve individuals with ID, and the technology transfer of HomeAssist. Note that a complete presentation of this work, from a Cognitive Science perspective, is given in the doctoral thesis of Lucile Dupuy published last year (2016).

4.2.1. Project-team positioning

There is a range of platforms for assisted living aimed at older adults that have been developed for more than a decade. Most of these platforms are used in a setting where participants come to a research apartment to perform certain tasks. This setting makes it difficult to assess user acceptance and satisfaction of the proposed approaches because the user does not interact with the technology on a daily basis, over a period of time. Furthermore, older adults adopt routines to optimize their daily functioning at home. This situation calls for field studies in a naturalistic setting to strengthen the evaluation of assisted living platforms.

HomeAssist innovates in that it supports independent living across the activities of daily living and is validated by field studies in naturalistic setting.

4.3. Assistive computing on-the-go

Participants: Cécile Mazon, Léo Mendiboure, Hélène Sauzéon, Charles Consel.

We conduct research on assistive computing supported by mobile devices such as smart phones and tablets. Both research projects presented in this section are supported by tablets and leverage their functionalities to guide users with cognitive challenges performing activities and tasks, whether in mainstream schools to support inclusion or in residential settings to support their autonomy. The mobile nature of tablets allows to envision such devices as supporting users with cognitive challenges across a range of environments.

Many research projects bring cognitive-support applications to users based on tablets and smartphones. However, few projects equip users with such devices in actual mainstream environments, including stakeholders in the design process and targeting an autonomous usage of assistive applications. An additional originality of our approach is our interdisciplinary approach that allows us to integrate key psychological dimensions in our design, such as self-determination.

4.4. Life Plan

Participants: Audrey Landuran, Gregory Lecouvey, Léo Mendiboure, Quentin Barlas, Bernard N'Kaoua.

Elaboration of life plan is a major stage in the developmental trajectory of people with intellectual deficiency and is based on several capabilities : make choices, express them, be aware of their consequences, etc. However, these various capabilities can raise problems for people with Down syndrome. The aim of this project has been to design and validate a digital assistant that allows to help the individuals to make choices, to plan for the future and to define their life plan. The user centered methodology employed has allowed to involve the people with Down syndrome, their families and their caregivers in all stages of design. Different validations achieved attest for the accessible, friendly, funny character of the assistant and its ability to promote the expression of the life plan in accordance with individuals' choices, wishes and desires.

The digital assistant is now available online at : http://www.monprojetdevie.trisomie21-france.org/.

5. Highlights of the Year

5.1. Highlights of the Year

The College+ software, an assistive application on iPad for children with Autism Spectrum Disorders included in ordinary schools, has been distributed on the Apple store, starting in October 2017.

https://itunes.apple.com/us/app/college/id1289697202

6. New Software and Platforms

6.1. College

KEYWORDS: Neurosciences - Health - Autism - Mobile application

Figure 2. Sample screenshots from the Life Plan website.

FUNCTIONAL DESCRIPTION: College+ is an iPad app gathering an assistance module and a training module for school inclusion in of children with autism spectrum disorders and children with intellectual disabilities in mainstream classrooms. The assistance module, used in mainstream classroom, comprises 3 functionalities: - emotion regulation - classroom routines - verbal communication. The training module, used on a daily basis at home or in special education classroom, comprises two functionalities, presented as serious games: - attention training - emotion identification training. All contents of College+ app can be modified, to fit the unique needs of each student.

- Participants: Alexandre Spriet, Charles Consel, Charles Fage, Damien Martin Guillerez and Hélène Sauzéon
- Partners: Université de Bordeaux - CNRS - IPB
- Contact: Charles Consel
- URL: http://phoenix.inria.fr/research-projects/school

6.2. College +

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FUNCTIONAL DESCRIPTION: College+ is an iPad app gathering an assistance module and a training module for school inclusion in of children with autism spectrum disorders and children with intellectual disabilities in mainstream classrooms. The assistance module, used in mainstream classroom, comprises 3 functionalities: - emotion regulation - classroom routines - verbal communication. The training module, used on a daily basis at home or in special education classroom, comprises two functionalities, presented as serious games: - attention training - emotion identification training. All contents of College+ app can be modified, to fit the unique needs of each student.

- Participants: Alexandre Spriet, Charles Fage, Damien Martin Guillerez and Hélène Sauzéon
- Contact: Charles Consel
- URL: http://phoenix.inria.fr/research-projects/school

6.3. DiaSuite

KEYWORDS: Pervasive computing - Code generation - Specification language
SCIENTIFIC DESCRIPTION: DiaSuite is a suite of tools covering the development life-cycle of a pervasive computing application:

Defining an application area. First, an expert defines a catalog of entities, whether hardware or software, that are specific to a target area. These entities serve as building blocks to develop applications in this area. They are gathered in a taxonomy definition, written in the taxonomy layer of the DiaSpec language.

Designing an application. Given a taxonomy, the architect can design and structure applications. To do so, the DiaSpec language provides an application design layer. This layer is dedicated to an architectural pattern commonly used in the pervasive computing domain. Describing the architecture application allows to further model a pervasive computing system, making explicit its functional decomposition.

Implementing an application. We leverage the taxonomy definition and the architecture description to provide dedicated support to both the entity and the application developers. This support takes the form of a Java programming framework, generated by the DiaGen compiler. The generated programming framework precisely guides the developer with respect to the taxonomy definition and the architecture description. It consists of high-level operations to discover entities and interact with both entities and application components. In doing so, it abstracts away from the underlying distributed technologies, providing further separation of concerns.

Testing an application.DiaGen generates a simulation support to test pervasive computing applications before their actual deployment. An application is simulated in the DiaSim tool, without requiring any code modification. DiaSim provides an editor to define simulation scenarios and a 2D-renderer to monitor the simulated application. Furthermore, simulated and actual entities can be mixed. This hybrid simulation enables an application to migrate incrementally to an actual environment.

Deploying a system. Finally, the system administrator deploys the pervasive computing system. To this end, a distributed systems technology is selected. We have developed a back-end that currently targets the following technologies: Web Services, RMI, SIP and OSGI. This targeting is transparent for the application code. The variety of these target technologies demonstrates that our development approach separates concerns into well-defined layers.

FUNCTIONAL DESCRIPTION: DiaSuite is developed as a research project by the Inria/LaBRI Phoenix research group. The DiaSuite approach covers the development life-cycle of a pervasive computing application. It takes the form of a methodology, supported by (1) a high-level design language and (2) a suite of tools covering the development life-cycle of a pervasive computing application. Specifically, we have developed a design language dedicated to describing pervasive computing systems and a suite of tools providing customized support for each development stage of a pervasive computing system, namely, implementation (e.g., programming support), testing (e.g., unit test, 2D simulator), and deployment (e.g., distribution platforms like SIP and Web Services).

- Participants: Adrien Carteron, Alexandre Spriet, Charles Consel, Milan Kabac, Paul Van Der Walt and Quentin Barlas
- Contact: Charles Consel
- URL: http://phoenix.inria.fr/software/diasuite

6.4. DiaSuiteBOX

KEYWORDS: Dedicated langage - Iot - Orchestration - Toolbox - Development tool suite
FUNCTIONAL DESCRIPTION: DiaSuiteBOX proposes an application store that gathers the devices deployed at home. This store is open and available online such as an application store for Smartphone.

- Participants: Adrien Carteron, Amélie Marzin, Bertran Benjamin, Bruneau Julien, Consel Charles, Damien Cassou, Damien Martin Guillerez, Emilie Balland, Eugène Volanschi, Hélène Sauzéon, Joan Rieu, Julien Durand, Ludovic Fornasari, Milan Kabac, Quentin Barlas and Quentin Enard
- Contact: Charles Consel
- URL: https://domassist.bordeaux.inria.fr/

6.5. DomAssist

KEYWORDS: Health - Mobile application - Persons attendant - Home care
FUNCTIONAL DESCRIPTION: 3 mobile applications for assistive living : - DiAndroid : Interface for the main tablet with the DiaSuiteBox applications including those for the daily activities, the meetings scheduling, etc. and for home and personal safety - Accueil : home screen restraining the use of a secondary tablet and offering communications and social activities applications with simplified communication means (ie. eMail), collaborative games, etc. - eMail : mail client made for older people

Other Vera gateway tools : - Controlling connected objects to the Vera home automation gateway from Android - Vera push plugin to domassist cloud: vera plugin to communicate sensor information associated with the gateway directly to DomAssist servers - Vera HeartBeat Plugin: Regular sending of a frame to know that the gateway is still online

- Participants: Alexandre Spriet, Quentin Barlas, Charles Consel, Hélène Sauzéon and Julien Durand
- Partners: Université de Bordeaux - CNRS - IPB
- Contact: Charles Consel
- URL: http://phoenix.inria.fr/research-projects/homeassist

7. New Results

7.1. Everyday Functioning Benefits from an Assisted Living Platform amongst Frail Older Adults and Their Caregivers

Ambient assisted living technologies (AAL) are regarded as a promising solution to support aging in place. Yet, their efficacy has to be demonstrated in terms of benefits for independent living and for work conditions of caregivers. Hence, the purpose of this study was to assess the benefits of a multi-task AAL platform for both Frail older Individuals (FIs) and professional caregivers with respect to everyday functioning and caregiver burden. In this context, a 6-month field study involved 32 FIs living at home (half of them were equipped by the platform and the remaining half were not, as a control condition) and their caregivers. Everyday functioning measures were reported by frail participants and caregivers. Self-reported burden measures of caregiver were also collected. The main results showed that the caregiver's estimates of everyday functioning of equipped participants were unchanged across time, while they decreased for the control participants. Also, a reduction of self-reported objective burden was obtained after 6 months of AAL intervention for the equipped group, compared to the control group. Overall, these results highlighted the potential of AAL as a relevant environmental support for preventing both functional losses in FIs and objective burden professional caregiver.

7.2. Designing Parallel Data Processing for Enabling Large-Scale Sensor Applications

Masses of sensors are being deployed at the scale of cities to manage parking spaces, transportation infrastructures to monitor traffic, and campuses of buildings to reduce energy consumption. These large-scale infrastructures become a reality for citizens via applications that orchestrate sensors to deliver high-value, innovative services. These applications critically rely on the processing of large amounts of data to analyze situations, inform users, and control devices. This work proposes a design-driven approach to developing orchestrating applications for masses of sensors that integrates parallel processing of large amounts of data. Specifically, an application design exposes declarations that are used to generate a programming framework based on the MapReduce programming model. We have developed a prototype of our approach, using Apache Hadoop. We applied it to a case study and obtained significant speedups by parallelizing computations over twelve nodes. In doing so, we demonstrate that our design-driven approach allows to abstract over implementation details, while exposing architectural properties used to generate high-performance code for processing large datasets. Furthermore, we show that this high-performance support enables new, personalized services in a smart city. Finally, we discuss the expressiveness of our design language, identify some limitations, and present language extensions.

7.3. Internet of Things: From Small-to Large-Scale Orchestration

The domain of Internet of Things (IoT) is rapidly expanding beyond research, and becoming a major industrial market with such stakeholders as major manufacturers of chips and connected entities (i.e., things), and fast-growing operators of wide-area networks. Importantly, this emerging domain is driven by applications that leverage an IoT infrastructure to provide users with innovative, high-value services. IoT infrastructures range from small scale (e.g., homes and personal health) to large scale (e.g., cities and transportation systems). In this work, we argue that there is a continuum between orchestrating connected entities in the small and in the large. We propose a unified approach to application development, which covers this spectrum. To do so, we examine the requirements for orchestrating connected entities and address them with domain-specific design concepts. We then show how to map these design concepts into dedicated programming patterns and runtime mechanisms. Our work revolves around domain-specific concepts and notations, integrated into a tool-based design methodology and dedicated to develop IoT applications. We have applied our work across a spectrum of infrastructure sizes, ranging from an automated pilot in avionics, to an assisted living platform for the home of seniors, to a parking management system in a smart city.

7.4. Designing an Accessible and Engaging Email Application for Aging in Place

Supporting independent everyday functioning of older adults is a major challenge for aging in place. In particular, communication and social activities need support to prevent social isolation, cognitive and psychosocial well-being decline, and a risk of depression. This paper focuses on how technology can bring social support to isolated older-old adults (over 75 years old) and allow them to communicate with members of their social network. We present the design of an accessible and engaging email application dedicated to this population. We propose design principles based on the older adults' specificities and then use these principles to develop a tablet-based email application. We conducted a field study to evaluate our email application during 9 months. We equipped 13 community-dwelling old-older adults with a touchscreen tablet and our application at their home (compared to 13 control counterparts). This field study validates our design principles as shown by the effectiveness and efficiency gained by the participants in using our application. Moreover, we reveal the influence of health indicators in the usage behaviors and the long-term use of our application.

7.5. HomeAssist: An Assisted Living Platform for Aging in Place Based on an Interdisciplinary Approach

HomeAssist is an assisted living platform aims to support aging in place. This platform was designed using a human-centered approach. It offers assistive services, addressing the main aspects of daily life: activities of daily living, home and user safety, and social participation. HomeAssist introduces key novel features: (1) it covers multiple aspects of daily life, addressing a variety of needs of older adults; (2) it provides customization mechanisms, adapting assistance to the user's abilities while preventing autonomy losses; (3) it relies on context awareness, delivering timely assistance; and, (4) it revolves around a unified user interface to achieve usability. All these features play a key role towards achieving high acceptance of HomeAssist and supporting autonomy effectively, as shown by our field study.

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Independent living with intellectual disabilities – ANDDI – 2014 - 2017*

ANDDI leverages the abilities of individuals with ID and the recent technological advances to develop a variety of assistive services addressing their daily needs. These services draw on our expertise in cognitive science and computer science, dedicated to assisting users with technologies. In particular, we use our platform, named HomeAssist, dedicated to the independently living of older adults. This project is funded by the Region of Aquitaine.

8.1.2. *Populational Study of HomeAssist – HomeAssist 500 – 2015 - 2017*

We conduct a Randomized Controlled Trial (RCT) of HomeAssist with older adults, ranging from autonomous to mildly cognitively impaired (e.g., Alzheimer disease (AD) in its early stage). The RCT is considered as the gold standard of a true experimental design. Furthermore, it provides strong evidence for causal relationships, as well as the ability to generalize the results to people outside the study's sample. The study design will thus be a single-blinded RCT. It will include up to 500 participants, matched with non-equipped participants. The HomeAssist intervention will involve monitoring as well as compensation services to support independent living in place. The duration of the HomeAssist intervention is of 12 months. This project is funded by the Region of Aquitaine, the Districts of Gironde and Pyrénées Atlantique, CARSAT Aquitaine, UDCCAS, and CNSA.

8.2. National Initiatives

8.2.1. School Inclusion for Children with Autism

The objective of this project is to provide children with assistive technologies dedicated to the school routines. This project is in collaboration with the "Handicap et Système Nerveux" research group (EA 4136, Bordeaux University), the PsyCLÉ research center (EA 3273, Provence Aix-Marseille University) and the "Parole et Langage" research laboratory (CNRS, Provence Aix-Marseille University).

This work is funded by the French Ministry of National Education and Orange Foundation.

8.3. International Initiatives

8.3.1. Participation in Other International Programs

- International exchange program Idex (2016-17) — "Memory, aging, Parkinson disease, and Virtual Reality", with Pr. Luc Noreau, Centre Interdisciplinaire de Recherche en réadaptation et intégration sociale-University of Laval, Canada. Coordinated by P. Dehail.
- Mobility program Idex UB-University of Waterloo, Canada — "Aging, Neurological conditions, and Assistance technologies" (2016-17). Coordinated by M. Fernandes and H. Sauzéon.

9. Dissemination

9.1. Promoting Scientific Activities

9.1.1. Scientific Events Organisation

9.1.1.1. Member of the Organizing Committees

Hélène Sauzéon & Bernard N'Kaoua, in cooperation with E. Morales & B. JMcFadyen, co-organized the Summer scool 2017 of Alliance Bordeaux-Laval: "Mobility in urban environment: a systemic approach centered on the person and his/her environment", 3-5 july 2017 at University of Laval (Québec, Canada).

9.1.2. Scientific Events Selection

9.1.2.1. Member of the Conference Program Committees

Charles Consel was member of the following Program Committees:
- ICSE 2018 SEIS Track (Software Engineering in Society)
- 3rd IEEE International Conference on Collaboration and Internet Computing
- International Workshop on Pervasive Systems Integration (PerSysT 2018)
- 2018 IEEE International Conference on Cloud Computing (CLOUD 2018)

9.1.2.2. Reviewer

Hélène Sauzéon served as a reviewer for the ACM CHI Conference on Human Factors in Computing Systems 2018.

9.1.3. Journal

9.1.3.1. Reviewer - Reviewing Activities

Hélène Sauzéon served as a reviewer for the following journals: British Journal of Psychology , Gerontology, Journal of Cognitive Psychology, PlosOne, Memory & Cognition, Aging, Neuropsychology & Cognition.

9.1.4. Invited Talks

Charles Consel was invited to give talks in the following contexts:

- University of Reading
- University of Toronto
- University of Illinois at Urbana-Champaign
- University of Indiana
- Digital Silver Forum on November 28 in Helsinki.

9.1.5. Scientific Expertise

Hélène Sauzéon participated as a scientific expert for:

- National call for proposals: IRSEP call "Autism and Technology", 2017
- Recruiting committees for:
  - Lecturer on Psychology et Ergonomics, Toulouse 2 University, 2017
  - Young researchers, Inria Bordeaux, since 2015
- The scientific committee of "Expertise center Calyxis for domestic risks" (Niort, France), working on R&D of technologies for preventing everyday accidents, thru collaboration programs between public labs and private companies.

9.1.6. Research Administration

Hélène Sauzéon has been a member of the Committee launching a new institute of advanced studies at the University of Bordeaux since 2016. In this context she participated at the design of this institute, leveraging his expertise in cognitive sciences and interdisciplinary research at Inria Bordeaux. Indeed, the aim of the institute is fostering interdisciplinary research, innovation, and creativity, by providing adequate financial support, educative and participative resources to researchers on the Bordeaux campus.

9.2. Teaching - Supervision - Juries

9.2.1. Teaching

- Master (M2) : Charles Consel, "Advanced topics — Technology surveys", 17h, Bordeaux INP, France
- Licence (L2): Hélène Sauzéon, "Modeling cognitive functions", 24h, University of Bordeaux, France.
- Licence (L3): Hélène Sauzéon, "Handicap, Executive functions, Cognitive neuropsycology", 12h, University of Bordeaux, France.
- Master (M1): Hélène Sauzéon, "Cognitive psychology, Aging, Human factors", 30h, University of Bordeaux, France.
- Master (M2): Hélène Sauzéon, "Handicap and assistive technology, Human factors and reliability of complex systems", 30h, University of Bordeaux, France.
- Master (M2): Hélène Sauzéon, "Neuropsychology: Evaluation, Language-related models and syndromes, Executive functions and syndromes", 30h, University of Bordeaux, France.
- Master (M2): Hélène Sauzéon, "Neuropshychology: Language-related models, Aging", 9h, University of Bordeaux, France.
- Master (M2) : Nic Volanschi, "Advanced topics — Technology surveys", 17h, Bordeaux INP, France
- Licence (L3) : Nic Volanschi, "Introduction to imperative programming", 24h, Bordeaux INP, France
- Master (M2) : Antoine Riché, "Software Engineering for Smart Spaces", 8h, Bordeaux INP, France

- Licence (L3) : Cécile Mazon, "Outils pour les enfants avec troubles cognitifs et apports de la psychologie cognitive", 6h, École d'Ergothérapie, CHU Bordeaux, France
- Licence (L3) : Cécile Mazon, "École inclusive et Technologies Numériques : Quels solutions pour les enfants avec troubles cognitifs ?", 8h, École d'Ergothérapie, CHU Bordeaux, France
- Licence (L2) : Cécile Mazon, "Handicap cognitif et Technologies d'assistance à la vie quotidienne", 8h, École d'Ergothérapie, CHU Bordeaux, France
- Licence (L2) : Bernard Serpette, "Functional Programming", 35h, Université de Bordeaux, France.

  E-learning

  MOOC: Hélène Sauzéon and Pascal Guitton, "Digital Accessibility" , open for unrestricted attendance, on the FUN national platform, supported by the Inria Learning Lab:

  - 1st session in november 2016: about 3800 registered students from 60 different countries
  - 2nd session in june 2017: about 1900 registered students

  The MOOC contents is still currently available on "Canal U".

9.2.2. Supervision

PhD : Adrien Carteron, "An event-based approach to the development of home assistance services for various stakeholders", University of Bordeaux, defended on December 22nd, 2017, co-directed by Charles Consel and Nic Volanschi.

PhD in progress : Cécile Mazon, "Personalization and evaluation of a digital assistant for school inclusion of college students with autism and/or intellectual disability", University of Bordeaux, started in September 2016, co-directed by Hélène Sauzéon and Charles Consel.

PhD in progress: Antoine Riché, "Architectures of assistive services based on software sensors", started in October 2016, directed by Charles Consel.

PhD in progress: Rafik Belloum, "A methodology for developing assistive services", started in 2016, directed by Charles Consel.

PhD in progress: Audrey Landuran, "Design, adaptation and validation of digital tools for people with intellectual disabilities', started in 2016, directed by Bernard N'Kaoua.

PhD in progress: P.A. Cinquin, "Conception et validation d'un lecteur accessible aux personnes avec troubles cognitifs pour un système d'enseignement numérique", started in 2016, co-directed by Hélène Sauzéon and Pascal Guitton.

PhD in progress: A. Delmas, "Conception et validation d'un site internet interactif sur l'asthme à visée éducative pour les enfants avec asthme", started in 2015, co-directed by Hélène Sauzéon and Pierre-Yves Oudeyer.

9.2.3. Juries

Charles Consel was member of the thesis committee for Tizneem Jiancaro, for her thesis entitled "Technology, Design and Dementia: Design approaches, implications and considerations for an emerging field". Supervisor: Alex Mihailidis, Ph.D P.Eng. Scientific Director AGE-WELL Network of Centres of Excellence, University of Toronto.

Hélène Sauzéon was member of the thesis committee for Castor Naomie, who performed her PhD in the Lab CHART-LUTIN (Paris 8 University).

Charles Consel and Nic Volanschi were members of the thesis committee for Adrien Carteron (as co-supervisors), for his thesis in Computer Science called "An event-based approach to the development of home assistance services for various stakeholders", University of Bordeaux, on December 22nd 2017.

9.3. Popularization

Nic Volanschi participated on October 12th to the "Science fest" at Inria Bordeaux, where he gave 3 workshop sessions on "Manual digital sciences" for children aged 11 to 15. These workshop sessions were aimed to communicate basic notions of computer science to young students by using puzzles and games.

Antoine Riché and Nic Volanschi presented, to a professional audience coming from various digital-related industries, some of the technologies developed in the team, at the Inria-Industry Meeting on October 17th-18th in Paris centered on "Data and their applications".

Cécile Mazon participated to the following popularization events:

- "1er Salon du livre et du numérique pour les dys", on 3rd may 2017. Representing the research center jointly with P.-A. Cinquin (Potioc team); presenting and demonstrating the Collège+ app for iPad.
- "PubHD Bordeaux", on 24th october 2017. Event consisting in presenting her PhD work "Technologies pour la scolarisation des collégiens avec TSA" without slides nor scientific jargon.
- Guest of the radio show "Que cherchent-ils", on RCF Bordeaux. 25 minutes for presenting her PhD work around autism and technologies. The show was recorded in december 2017 and wiil be broadcast in february – march 2018.
- Largely open congress "ITASD", in july 2017, Valencia, Spain. "Effectiveness and Usability of Technology-based interventions for children and adolescents with ASD: A systematic review of reliability, consistency, durability and generalization related to the effects of interventions". The abstract is available within the conference proceedings.

10. Bibliography

Major publications by the team in recent years

[1] E. BALLAND, C. CONSEL, H. SAUZÉON, B. N'KAOUA. *A Case for Human-Driven Software Development*, in "ICSE'13: Proceedings of the 35th International Conference on Software Engineering (NIER track)", San Francisco, United States, May 2013, http://hal.inria.fr/hal-00814296

[2] B. BERTRAN, J. BRUNEAU, D. CASSOU, N. LORIANT, E. BALLAND, C. CONSEL. *DiaSuite: a Tool Suite To Develop Sense/Compute/Control Applications*, in "Science of Computer Programming, Fourth special issue on Experimental Software and Toolkits", January 2014, vol. 79 [*DOI :* 10.1016/J.SCICO.2012.04.001], https://hal.inria.fr/hal-00702909

[3] D. CASSOU, E. BALLAND, C. CONSEL, J. LAWALL. *Leveraging Software Architectures to Guide and Verify the Development of Sense/Compute/Control Applications*, in "ICSE'11: Proceedings of the 33rd International Conference on Software Engineering", Honolulu, United States, ACM, 2011, pp. 431-440, http://hal.inria.fr/inria-00537789/en

[4] D. CASSOU, J. BRUNEAU, C. CONSEL, E. BALLAND. *Towards a Tool-based Development Methodology for Pervasive Computing Applications*, in "IEEE TSE: Transactions on Software Engineering", 2012, vol. 38, n° 6, pp. 1445-1463, http://hal.inria.fr/hal-00683210

[5] C. CONSEL, L. DUPUY, H. SAUZÉON. *A Unifying Notification System To Scale Up Assistive Services*, in "ASSETS - The 17th International ACM SIGACCESS Conference on Computers and Accessibility", Lisbon, Portugal, October 2015, https://hal.inria.fr/hal-01225637

[6] L. DUPUY, C. CONSEL, H. SAUZÉON. *Self Determination-Based Design To Achieve Acceptance of Assisted Living Technologies For Older Adults*, in "Computers in Human Behavior", September 2016, vol. 65, Accepted for publication in the journal Computers In Human Behavior [*DOI :* 10.1016/J.CHB.2016.07.042], https://hal.inria.fr/hal-01351332

[7] C. FAGE, L. POMMEREAU, C. CONSEL, E. BALLAND, H. SAUZÉON. *Tablet-Based Activity Schedule in Mainstream Environment for Children with Autism and Children with ID*, in "ACM Transactions on Accessible Computing ", March 2016, vol. 8, n° 3 [*DOI :* 10.1145/2854156], https://hal.archives-ouvertes.fr/hal-01330442

[8] M. KABÁČ, C. CONSEL. *Designing Parallel Data Processing for Large-Scale Sensor Orchestration*, in "13th IEEE International Conference on Ubiquitous Intelligence and Computing (UIC 2016)", Toulouse, France, July 2016, Best Paper Award, https://hal.inria.fr/hal-01319730

[9] J. MERCADAL, Q. ENARD, C. CONSEL, N. LORIANT. *A Domain-Specific Approach to Architecturing Error Handling in Pervasive Computing*, in "OOPSLA'10: Proceedings of the 25th Annual ACM SIGPLAN Conference on Object Oriented Programming Systems Languages and Applications", États-Unis Reno, October 2010

[10] M. TAILLADE, H. SAUZÉON, P. ARVIND PALA, M. DÉJOS, F. LARRUE, C. GROSS, B. N'KAOUA. *Age-related wayfinding differences in real large-scale environments: detrimental motor control effects during spatial learning are mediated by executive decline?*, in "PLoS ONE", 2013, vol. 8, n° 7 [*DOI :* 10.1371/JOURNAL.PONE.0067193], http://hal.inria.fr/hal-00906837

[11] P. VAN DER WALT, C. CONSEL, E. BALLAND. *Frameworks compiled from declarations: a language-independent approach*, in "Software: Practice and Experience", May 2016 [*DOI :* 10.1002/SPE.2417], https://hal.inria.fr/hal-01236352

Publications of the year

Doctoral Dissertations and Habilitation Theses

[12] A. CARTERON. *An event-driven approach to developing interdisciplinary services dedicated to aging in place*, Université de Bordeaux, December 2017, https://hal.inria.fr/tel-01663150

Articles in International Peer-Reviewed Journals

[13] L. DUPUY, C. FROGER, C. CONSEL, H. SAUZÉON. *Everyday Functioning Benefits from an Assisted Living Platform amongst Frail Older Adults and Their Caregivers*, in "Frontiers in Aging Neuroscience", September 2017, vol. 9, pp. 1-12 [*DOI :* 10.3389/FNAGI.2017.00302], https://hal.inria.fr/hal-01597680

[14] M. KABÁČ, C. CONSEL, N. VOLANSCHI. *Designing Parallel Data Processing for Enabling Large-Scale Sensor Applications*, in "Personal and Ubiquitous Computing", 2017 [*DOI :* 10.1007/S00779-017-1009-1], https://hal.inria.fr/hal-01470281

International Conferences with Proceedings

[15] L. CAROUX, C. CONSEL, H. SAUZÉON, L. DUPUY. *Designing an Accessible and Engaging Email Application for Aging in Place*, in "UIC 2017 - IEEE International Conference on Ubiquitous Intelligence and Computing", San Francisco, United States, IEEE (editor), August 2017, 8 p. , https://hal.inria.fr/hal-01556783

[16] C. CONSEL, M. KABÁČ. *Internet of Things: From Small-to Large-Scale Orchestration*, in "The 37th IEEE International Conference on Distributed Computing Systems (ICDCS 2017)", Atlanta, GA, United States, June 2017, https://hal.inria.fr/hal-01544578

[17] L. PILLETTE, C. JEUNET, B. MANSENCAL, R. N 'KAMBOU, B. N 'KAOUA, F. LOTTE. *PEANUT: Personalised Emotional Agent for Neurotechnology User-Training*, in "7th International BCI Conference", Graz, Austria, September 2017, https://hal.archives-ouvertes.fr/hal-01519480

Scientific Books (or Scientific Book chapters)

[18] C. CONSEL, L. DUPUY, H. SAUZÉON. *HomeAssist: An Assisted Living Platform for Aging in Place Based on an Interdisciplinary Approach*, in "Advances in Human Factors and Ergonomics in Healthcare and Medical Devices", Springer, July 2017, vol. 16, pp. 165 - 140 [*DOI :* 10.1007/978-3-319-60483-1_14], https://hal.inria.fr/hal-01541939

[19] C. FAGE, P. MOULLET, C. CONSEL, H. SAUZEON. *France*, in "The Praeger International Handbook of Special Education", M. L. WEHMEYER, J. R. PATTON (editors), ABC-CLIO Corporate ABC-CLIO, April 2017, vol. 2, 26 p. , https://hal.inria.fr/hal-01354195

Other Publications

[20] C. JEUNET, B. N 'KAOUA, F. LOTTE. *Towards a cognitive model of mi-bci user training* , May 2017, working paper or preprint, https://hal.archives-ouvertes.fr/hal-01519476

References in notes

[21] J. ALDRICH, V. KOSTADINOV, C. CHAMBERS. *Alias Annotations for Program Understanding*, in "OOP-SLA'02: Proceedings of the 17th International Conference on Object-Oriented Programming, Systems, Languages, and Applications", New York, NY, USA, ACM, 2002, vol. 37(11), pp. 311–330

[22] P. FEILER. *The Architecture Analysis & Design Language (AADL): An Introduction*, DTIC Document, 2006

[23] S. GATTI, E. BALLAND, C. CONSEL. *A Step-wise Approach for Integrating QoS throughout Software Development*, in "FASE'11: Proceedings of the 14th European Conference on Fundamental Approaches to Software Engineering", Sarrebruck, Germany, Lecture Notes in Computer Science, Springer, March 2011, vol. 6603, pp. 217-231, http://hal.inria.fr/inria-00561619

[24] H. JAKOB, C. CONSEL, N. LORIANT. *Architecturing Conflict Handling of Pervasive Computing Resources*, in "11th IFIP International Conference on Distributed Applications and Interoperable Systems (DAIS'11)", Reykjavik, Iceland, June 2011, http://hal.inria.fr/inria-00581604

[25] R. N. TAYLOR, N. MEDVIDOVIC, E. M. DASHOFY. *Software Architecture: Foundations, Theory, and Practice*, Wiley, 2009

[26] N. UBAYASHI, J. NOMURA, T. TAMAI. *Archface: A Contract Place Where Architectural Design and Code Meet Together*, in "ICSE'10: Proceedings of the 32nd International Conference on Software Engineering", New York, NY, USA, ACM, 2010, pp. 75–84

[27] S. VESTAL. *An Overview of the Architecture Analysis & Design Language (AADL) Error Model Annex*, in "AADL Workshop", 2005