MuseARTS: MUlti-SEnsory Makers for the ARTS

Appel ANR Générique 2015, Projet de recherche collaborative (PRC)

Composante : Grand défis sociétaux, *défi 7* : Société de l'information et de la communication, *Axe 3*: Le numérique au service des arts, du patrimoine, des industries culturelles et éditoriales, *OPR :* Nouvelles dimensions créatives.

Summary

The *MuseARTS* project aims at leveraging the trend in Art/Science creativity beyond discourse in compliance with the *Makers* Movement. The project brings together main actors in *Digital Innovation* across France each specialized with worldwide recognition in Music and Sound, Robotics, Interaction Design, Narrative Design, Virtual Reality, and Tangible Media for creating the next generation of *Digital Objects* capable of integrating all aforementioned disciplines. The scientific consortium is joined by a group of world-famous *Artists* whose prior practices and current obsessions call for *hybrid projects* across the digital world, *challenge assumptions* and *lead to new ideas*.

The originality of *MuseARTS* is within two folds: (1) It brings in 5 different laboratories together from across the country that work on disjoint and complementary fields of research whose coupling is now urgent within new Digital Society. (2) The proposal's success is assessed through multi-disciplinary sub-projects run by an artistic body.

This joint venture between Arts and Sciences between research teams focused on digital media in 4 different locations, and IRCAM brings several benefits: It creates synergy on projects with components from different disciplines (**transdisciplinary**) and fosters creativity and outreach between them (**interdisciplinary**). Scientific outcome of the project should address new horizons crossing multi-modal aspects of Digital Objects; and their collaboration with world-renown artists should create international outreach. The project coordinator (IRCAM) has longstanding experience in assessing both "intellectual merit and broader impact" for the sciences and "artistic excellence".

Context and Strategic Justifications

The digital world has invaded all our senses and every day experience. *Being Digital* is no longer limited to excellence in a single field of research but calls for **integrative research** across all disciplines. The interactive experience between the physical world, humans and the digital world pass through **multi-sensory experience** ranging from listening, vision, contact, tangible surfaces, virtual reality and more. At the same time - despite localized success in music and vision – *scientific, technical and industrial cultures* gain tremendous recognition in our society but remain excluded from other cultural spheres; and state-of-the-art interactive agents lack multi-sensory experience and their deployment is far from public outreach.

On another trend, the modern digital world is hugely influenced by the **Makers Movement** which consists of individuals ranging from classroom students to amateurs and researchers who aim at building and re-building objects using **Open Hardware and Open source technology** which was in hands of privileged industry and research labs beforehand. The raise of the *Poppy Robot* (by Partner Flowers/Bordeaux) is an example. Among active body of Makers, **Artists** have played and continue to play a crucial role. It is important to note that the popular *Arduino* technology was initially a movement in the arts. The MuseARTS project is an integrated response to this movement for fostering scientific research and artistic creativity.

The research program of *MuseARTS* aims at leveraging the interaction between the physical, human and digital worlds and conceives new objects and interactive services, with their development tools for the greater public. By integrating various world-class artists in our project, our major focus is in the integration of **Humans in the loop of conception and computing**. *MuseARTS* is a unique collaboration of world-famous research teams in the fields of *Sound and Music* (Ircam/Paris), *Robotics* (Flowers /Bordeaux), *Interaction Design* (Potioc/Bordeaux), *Narrative Design* (Imagine /Grenoble), *Tangible Media* (MINT/Lille) and *Virtual Reality* (Hybrid/Rennes). Our highly trans- and inter-disciplinary research will touch **various aspects of digital creativity.** Outcome of research focuses on the employment and deployment of **multi-sensory digital interaction**: Buildable robots with multi-sensory interaction and learning capabilities with humans, multi-sensory immersive media, time-based interactive scenarios through tangible interfaces, and more. Our goal-based methodology through integrating artistic projects,

guides our research to the study of **Novel New Media Authorship**, allowing artists (and consequently every maker) to focus on intelligible information and representations by specialized *Coordination Languages* achieving complex digital interactive creativity integrating multiple mediums.

The *MuseARTS* project integrates several pre-selected artistic projects to enforce its **goal-oriented approach**. The artistic projects are by themselves funded independently from this call through artistic consortiums run by IRCAM. *MuseARTS* will integrate their production at the very onset on the scientific and technical aspects involving new digital technologies. Artists are the best *mediators between the society and research laboratories*, and our selection of established artists with international careers will enforce our **outreach to the society** and **leverage new dimensions in digital creativity**. The artistic projects range from staging of robots (with George Aperghis), interactive Opera (Diana Soh) and immersive installations (Cyril Teste). Each project naturally integrates various digital innovations researched by the consortium but whose integration is far from evident and requires innovative multidisciplinary research. The impact of the project is thus limited neither to its scientific nor to its artistic output, but targets wide democratization of Digital Innovation with the help of arts and strengthens France's and Europe's position in the Digital Society as asked by this call.

The *MuseARTS* consortium was formed in mid-2014 through a joint initiative between IRCAM (The largest institution dedicated to Sound & Music Computing with extensive experience and presence in Art/Science) and INRIA (the main actor of Digital Innovation in France)[1]. The consortium includes **five complementary research teams across France**. This proposal is the result of several meetings and on-site visits by various artists and their final selection by the consortium reflecting our ambitions. The *MuseARTS* project will finance the research objectives, mediated by ambitious artistic projects with **potential international impact**.

Scientific Objectives

Leveraging the world of *Makers* with multi-sensory Digital Objects requires **Integrative Research** that addresses both **Interoperability between Heterogeneous Objects** often limited to a few modes of interaction, and equips this workflow with **Dedicated Authoring and Deployment Environments**.

Current efforts in providing integrated approaches to multi-sensory system building are sparse and focus on one or few aspects of digital interactions. In Interactive Arts for example, there exist domain-specific environments for interactive Audio/Video computing (ex. *MAX* and *PureData*), interactive gesture and video (ex. *EyesWeb*), and video game engines (ex. *Unity*) just to name a few and constantly growing; each with their lacks limiting their use to specific digital content workflow. There are few integrative efforts to overcome this lack. On a conceptual level, one important example is the *SCADE System* for Aeronautic Industry with a graphical programming front-end enabling heterogeneous programing for highly critical embedded systems but in purely static scenarios limiting their use for interactive multimedia.

MuseARTS partners have extensive experience with software and environments in their respective fields. Our approach in *MuseARTS* rely on taking the advantage of existing workflows and their respective user eco-system and providing high-level mechanisms for users and makers allowing interoperability, authorship and deployment of multi-sensory interactive Digital Objects. The overall scientific objective of the MuseARTS project is three folds corresponding to three main work-packages:

(1)   Interoperability: To achieve multi-sensory interfaces, we rely on the excellence of each scientific partner in their respective fields, and aim at studying and deploying **interoperability mechanisms among Digital Objects**. This objective aims at explicit formalization of *Models of Computations* allowing online collaboration of heterogeneous components pertained to auditory, visual, tactile and immersive experience between physical, human and digital worlds. This work-package will be divided into several tasks putting in interaction partners on specific extensions of their technology for other partners. Interoperability will be studied both on the hardware and software (algorithmic) levels. To achieve **Hardware Interoperability** we will focus on prototyping methods in practice in each lab often with popular or domain-specific computing devices and tangible interfaces provided by partners (Potioc, MINT). **Algorithmic Interoperability** focuses on methods to achieve multi-sensory perception and reactions during computing. For example, the use of *Interactive Sound Processing & Recognition* (IRCAM) should enhance *virtual reality* experience (Hybrid/Rennes) and embedded into *social robots*

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(Flowers/Bordeaux). On another matter, *animated 3D scene design* technology (Imagine/Grenoble) can be further extended using *interactive multi-touch technology* (Potioc/Bordeaux) and *tangible interfaces* (MINT/Lille).

(2)   Authorship: Manipulating heterogeneous media requires ***integrated authoring environments*** transposable to computations and modules of each media in hand. A major challenge for such authoring environment is their *expressivity* with regards to *temporal media* such as audio, video; *behavioral* and movement dimensions in robots; and narrative structure as in interactive video games; and their *correctness* during execution. Existing environments are ad-hoc and do not extrapolate well to systems integrating multiple media, nor are able to guarantee behavior in real-time interactions especially when *timeliness* is a factor of success. Popular authoring interface for New Media like MAX and PureData are examples of such shortcomings with limited interactive workflow. The project coordinator has been coordinating the *INEDIT ANR project* on this matter for interactive audio (ends 9/2015). This approach relies on *synchronous reactive coordination languages* that embed heterogeneous technologies within a system guaranteeing correctness through formal verifications within the award winning *Antescofo language*. Partners at Grenoble (IMAGINE) have developed tools for preparing/rehearsing live performances using 3D animation that would, during this project, include simulating the control of the robots using visual programming. Such efforts will be continued and extended to other digital mediums excelled by partners.

(3)   Integrative Deployment: Interoperable objects whose interactive behavior is formally modeled should be deployed on ***autonomous devices*** ready to bridge the gap between the physical, human and digital worlds. Such integrative deployment is way beyond mere engineering and requires a formal deployment system that propels software components to everyday hardware. Special effort will be given to *Open Hardware* and *Open Source* technologies in the design process.

Implementation of the MuseARTS project will allow technology exchange (hardware and software) between partners and continuous expertise exchange. The *goal-based* methodology through ambitious artistic project (exposed in the next section) will foster collaborations. The scientific objectives of the MuseARTS project goes beyond an ***Integrative Research*** program. It also allows improvements of state-of-the-arts systems already in possession of partners (*Antescofo* at IRCAM, *Poppy* at Flowers, etc.). Our methodology aims at broadening their global impact, and naturally renewing practices in digital creativity.

Methodology and Impact

MuseARTS scientific partnership revolves through the scientific objectives and work packages summarized in the previous section. To assure their success and broad impact, we adopt a ***goal-based*** methodology based on three major ***artistic partnerships***. Through partnership with IRCAM, the project disposes the necessary tools to achieve and disseminate such hybrid Art/Science collaboration to the international level. This hybrid methodology allows constant feedback and interaction between scientific prototypes and ground reality through employment in real-world interactive scenarios imposed by artistic projects, as well as rapid dissemination. We present three artistic projects identified by *MuseARTS* consortium with the help of IRCAM. Artistic project management is done at IRCAM by dedicated departments.

- **George Aperghis,** *Machinations II***:** George Aperghis is internationally known for his unique hybrid approach between music and theater (http://www.aperghis.com/). His work *Machinations* (IRCAM, 2000) is a break-through involving interactive technologies for sound and video at the time and has enjoyed performances in Europe, Asia, and America. In this second volume (Commissioned by IRCAM), Aperghis is willing to employ *Poppy Robots* (by Flowers) on stage interacting freely among themselves, other connected objects and a human performer/singer on stage. The poetic idea is to explore *a society that auto-organizes* and the role of human in defining its destiny. The project is expected for the IRCAM Manifeste Festival in 2017 with intermediate stages as *Interactive Installations* earlier. Engineers and scientists from MuTant, Flowers, Potioc and Mint will be involved.
- **Diana Soh's** *Interactive Chamber Opera:* Among the most promising composers of her generation, Diana Soh (http://www.dianasoh.com/) has emerged recently through her extensive use of interactive coupled gesture/audio interfaces. In this project, she is aiming at revolutionizing the realm of Opera where the public will interfere with the evolution of the narrative design through connected objects. It involves *Interactive Narrative Design* close to video games but in complex multi-user interactive setup and planned for 2018. IMAGINE Team (Grenoble) will have a lead role in this project for *Interactive Drama* involving other partners for interactive scenario and authorship.

- **Cyril Teste/MXM Collective** *Immersive Drama:* The MXM Collective led by Cyril Teste (http://collectifmxm.com/) is among the forerunners of new media art in France and Europe. In a recent artistic prototype (commissioned by IRCAM) he staged an interactive drama based one's imaginative childhood. Recent meetings of MuseARTS collective with the artist, revealed his extensive capacity to build an *Immersive Installation* where users explore a poetical space evoking childhood, past, present and glance of future. This project will involve Hybrid team as well as Potioc and MINT for interactive and tangible interfaces.

The projects and their artist are chosen based on their potential international impact. Prototypes developed for each project will be disseminated in forms of reusable/rebuildable hardware and software to the broader community. The project is designed in a way that work-package intermediate results collapse with each stage of artistic production.

Partnership

The *MuseARTS* consortium brings together 5 different laboratories with excellence in 5 aspects of the digital world. For details on the relevance of partners to this proposal, visit the consortium private website at http://forumnet.ircam.fr/inriart/ (password : inriart). Partners include:

- **IRCAM / Paris:** The joint *MuTant Team* (http://repmus.ircam.fr/mutant, Arshia Cont, leader) between IRCAM, INRIA, CNRS and UPMC acts as the coordinator of the project. The MuTant team is specialized in Synchronous Real-time Programming of Music Signals and home to the award winning *Antescofo system,* a standard system for interactive music. The team hosts researchers with expertise in Machine Learning, Formal Methods and Embedded Systems. Besides being a scientific research institution (CNRS UMR 9912), IRCAM is also home to artists and hosts the yearly MANIFESTE festival. IRCAM disposes specific departments and facilities for managing artistic projects, productions and dissemination around the world.

- **Flowers / Bordeaux** (http://flowers.inria.fr) is a joint project-team between Inria and Ensta ParisTech, headed by Pierre-Yves Oudeyer. The team is internationally known in the domain of developmental and social robotics, within an interdisciplinary approach that leverages robotics, psychology and neuroscience. It has been pioneering models of artificial curiosity and language evolution in robots. The team designed the first worldwide open-source 3D printed humanoid robot, targeted to rapid exploration of robotic morphologies by scientists, students and artists (http://www.poppy-project.org). The team has also a record of collaborative projects with artists, including the "Ergo-Robot experiment" realized in collaboration with moviemaker David Lynch (https://flowers.inria.fr/robots/ergo-robots/). Pierre-Yves Oudeyer, laureate of an ERC grant, will coordinate Flowers action in MuseARTS.

- **Potioc / Bordeaux** (http://team.inria.fr/Potioc) is a joint project-team between Inria, Université de Bordeaux and CNRS, headed by Martin Hachet. The overall objective of Potioc is to explore new approaches that favor rich interaction with the digital world through engaging and motivating interfaces, with the final goal of stimulating creation, learning, or entertainment. In particular, Potioc has proposed new interactive and immersive systems dedicated to music creation, drawing, and theatre. Martin Hachet, who has led and is leading the InSTInCT and ISAR ANR projects will coordinate Inria Potioc actions within the current project.

- **MINT / Lille** research team, led by Laurent Grisoni, is an HCI group targeted to proposing methods and tools to understand, and leverage, tactile and gesture-based interaction. It focuses on finding novel interaction techniques, understanding tactile and gesture-based interaction, as well as hardware for such interaction systems. It publishes at highest scientific level in HCI, VR, and haptic community. Since 2010 the MINT group has been collaborating with several artists, most of them issued from Le Fresnoy contemporary art national studio. An example of such collaboration is available at http://www.microsoft.com/eu/whats-next/multimedia/become-the-director-of-your-own-orchestra-with-damassama.aspx . More informations available at http://www.lifl.fr/mint .

- **IMAGINE / Grenoble** (https://team.inria.fr/imagine/team/) is a joint team between Laboratoire Jean Kuntzmann and Inria Grenoble Rhone Alpes, aiming to address the challenges brought by the efficient, interactive creation of animated 3D content. To this end, the team's goal is to develop a new generation of knowledge-based models for shapes, motion, stories and virtual cinematography. IMAGINE's work focuses on areas of *Shape Design, Motion Synthesis, Narrative Design* and *Virtual prototypes* with prior experience in Art/Science through collaborations with artists at Theatre des Celestins in Lyon. Rémi Ronfard will coordinate IMAGINE efforts in the project.

- **Hybrid / Rennes** (https://team.inria.fr/hybrid/) is a research team hosted jointly at Inria Rennes-Bretagne Atlantique and IRISA laboratory. The scientific fields of Hybrid are *Virtual Reality* and *3D interaction* with virtual environments. Hybrid research focuses on multiple user inputs, and intends to exploit both motor activity (motion-tracking) and mental activity (brain-computer interfaces). Hybrid hosts a large research platform on immersive virtual reality, *Immersia* (http://www.irisa.fr/immersia), a node of the European project *Visionair*. Anatole Lécuyer and Ronan Gaugne will coordinate Hybrid and Immersia.

The *MuseARTS* project funding will be spent on recruiting **2 PhD students** for relatively unexplored areas for partners such as Narrative Design (Grenoble) and Formal Models for multi-sensory authoring (IRCAM) and co-directed by consortium members; **2 research engineers** for partners in Bordeaux and Rennes helping the integration of their technologies in multi-sensory environments and preparing open building blocks; and **1 post-doc** on tangible interfaces between centers at Lille and Bordeaux. Further support is requested for equipping partners with devices as provided by other partners (*Poppy* robots, open hardware platforms, Mobile Immersive technologies and tangible media) whenever tasks require such partnership. Artistic projects are not funded by *MuseARTS* but by proper artistic co-producers but will enjoy deployment and exploration of new digital object out of collaboration with our consortium.

MuseARTS will be **coordinated by IRCAM's Arshia Cont**, researcher and leader of MuTant team-project. Arshia Cont is an established researcher at the intersection of Sciences and the Arts. He is the laureate of several awards (*Gilles Kahn Award* from Academy of Science, *Prix La Recherche 2012*, French Industry Prize 2013) and appears regularly as keynote in public scientific events on the subject nationally (College de France, TEDx, CNRS Fondamentales), on international scenes and public press (*Le Monde, Telerama, Figaro, BFM, France 2 Télématin,* etc.). He is the founder of the award-winning *Antescofo* project at IRCAM. He is currently coordinating the ANR INEDIT project (ending 9/2015) that aims at articulating between synchronous/asynchronous models in interactive art environments that will be precious to this project. Besides activity as researcher, he is the director of IRCAM's Research/Creativity Interfaces, coordinating between scientific and artistic activities of the institute.

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