2018-00707 - Haptic-enabled interaction techniques for Mixed Reality (MR) applications

Level of qualifications required: Graduate degree or equivalent
Function: PhD Position

About the research centre or Inria department
The Inria Rennes - Bretagne Atlantique center is one of Inria's eight centers and has more than thirty research teams. The Inria Center is a major and recognized player in the field of digital sciences. It is at the heart of a rich R&D and innovation ecosystem: highly innovative PMEs, large industrial groups, competitiveness clusters, research and higher education players, laboratories of excellence, technological research institute, etc.

Context
This PhD is in the field of Virtual Reality and Haptic Interfaces (i.e., technologies aiming at providing touch and force sensations). Its objective is to study a novel approach for introducing haptic sensations in virtual environments, based on a new generation of haptic technologies involving ultrasonic and/or vibratory stimulation to the user. The ambition of the PhD consists in designing novel rendering algorithms and interaction techniques to better exploit these new haptic technologies. Applications will include gaming, industrial training, teleoperation, rehabilitation, e-commerce.

Assignment
Digital content today remains focused on visual and auditory stimulation. Even in the realm of VR and AR, sight and sound remain paramount. In contrast, methods for delivering haptic (sense of touch) feedback in commercial media are significantly less advanced than graphical and auditory feedback. Yet without a sense of touch, experiences ultimately feel hollow, virtual realities feel false, and Human-Computer Interfaces become unintuitive.

To address these limitations, we want to integrate (i) pioneering ultrasonic “non-contact” haptic devices, (ii) state-of-the-art vibrotactile actuators, (iii) novel mathematical and tribological modelling of the skin with (iv) our experience in immersive VR and AR environments.

The result will be a sensory experience where digital 3D shapes and textures are made manifest in real space via modulated, focused, ultrasound, ready for the untethered hand to feel, where next-generation wearable haptic rings provide directional vibrotactile stimulation, informing users of an object's dynamics, and where computational renderings of specific materials can be distinguished via their surface properties.

(a) Non-contact haptics (ultrasound haptic system), b) Contact haptics (vibrotactile haptic rings), c- d) The next generation of AR/VR haptics proposed in this project.

The PhD project will proceed by developing three main key aspects:

- Interaction techniques for multi-modal contact/non-contact haptics. We will design high-level interaction techniques combining the capabilities of contact (wearable haptic rings) and non-contact (ultrasound systems) haptics in VR/AR environments. We will study solutions addressing the known limitations of the proposed system, e.g., under-actuation, limited range of forces, and potential visual occlusions (in an AR context).
- 2D surface interaction. We will develop and evaluate VR and AR applications to demonstrate the effectiveness of our haptic system in the rendering of mechanical properties of a virtual surface, e.g., shape, stiffness, texture.
- 3D object manipulation. We will develop and evaluate VR and AR applications to demonstrate the effectiveness of our haptic system in the rendering of 3-dimensional objects. Specifically, we will exploit the extreme wearability of our haptic system to enable users to physically manipulate real and virtual objects concurrently, for instance while sitting at an augmented desk of real and virtual objects.

The PhD student will be required to develop novel rendering algorithms in VR/AR, design novel interaction techniques, and conduct of several user studies and experiments with human participants. We also plan exchanges and meetings with academic and industrial partners in different European countries, so the student should be ready to travel.

Main activities
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- Design high-level interaction techniques combining the capabilities of contact (wearable haptic rings) and non-contact (ultrasound systems)
haptics in VR/AR environments.
- Develop and evaluate VR and AR applications to demonstrate the effectiveness of our haptic system in the rendering of mechanical properties of a virtual surface, e.g., shape, stiffness, texture.
- Develop and evaluate VR and AR applications to demonstrate the effectiveness of our haptic system in the rendering of 3-dimensional objects.

Additional activities:
- Write reports on the activities carried out.
- Present the results to international conferences and meetings.

Skills
We are looking for excellent, highly-motivated students interested in Mixed Reality and haptics, with a computer science background and previous experience in computer programming (C++). Experience in using VR/AR tools and systems (e.g., Unity 3D, ARToolkit, Oculus Rift, HoloLens) is considered a plus.

Benefits package
- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration
Monthly gross salary amounting to 1982 euros for the first and second years and 2085 euros for the third year.

General Information
- Theme/Domain: Interaction and visualization
- Software Experimental platforms (BAP E)
- Town/city: Rennes
- Inria Center: CRI Rennes - Bretagne Atlantique
- Starting date: 2018-10-01
- Duration of contract: 3 years
- Deadline to apply: 2018-08-31

Contacts
- Inria Team: HYBRID
- Recruiter: Lecuyer Anatole / anatole.lecuyer@inria.fr

About Inria
Inria, the French National Institute for computer science and applied mathematics, promotes “scientific excellence for technology transfer and society”. Graduates from the world’s top universities, Inria’s 2,700 employees rise to the challenges of digital sciences. With its open, agile model, Inria is able to explore original approaches with its partners in industry and academia and provide an efficient response to the multidisciplinary and application challenges of the digital transformation. Inria is the source of many innovations that add value and create jobs.

Conditions for application
Please submit online: your resume, cover letter and letters of recommendation.

For further information, please contact Claudio Pacchierotti: claudio.pacchierotti@irisa.fr, Maud Marchal: Maud.Marchal@irisa.fr

Defence Security:
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy:
As part of its diversity policy, all Inria positions are accessible to people with disabilities.

Warning: you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.