Position Description

1. General Information

Name of the position	**Cross-reality in interactive robotic using VR/AR**
Foreseen date of enrolment	January 2025
Position is funded by	• COFUND, Marie Skłodowska-Curie Actions (MSCA), Horizon Europe, European Union • École Nationale d'Ingénieurs de Brest (ENIB) • University of South Australia (UniSA)
Research Host	École Nationale d'Ingénieurs de Brest (ENIB)
PhD awarding institutions	École Nationale d'Ingénieurs de Brest & University of South Australia
Locations	Primary: Brest, France Secondary: Adelaide, Australia
Supervisors	Pr Cédric BUCHE (ENIB) Pr Ronan QUERREC (ENIB) Dr James WALSH (UniSA) Dr Andrew CUNNINGHAM (UniSA)
Group of discipline	Computer Science, Virtual Reality, Augmented Reality, Robotic, Human-Computer interaction

2. Research topics (only one of these projects will be funded)

Project 1: *Supporting cross reality robotic interaction*
Background: Currently robots are developed in two separate realities: in the physical world using the real robot, and in a simulated world using a virtual robot. Using the real world allows interaction with the users, but this option can be time consuming and unsafe when testing complex algorithms (navigation, grasping …). Using a virtual world can speed up development, is safe, but breaks the natural interaction with the user. In addition, the virtual world can fail to simulate sensors/effectors of the robot and therefore differ from reality. Mixed realities have the potential to make a "bridge" between the real and virtual worlds, taking advantage of both realities. It's advantageous to be able to develop their capabilities simultaneously across the real world, augmented reality (AR), virtual reality (VR), and robotic simulation. Using an immersive system (HMD, CAVE), a (virtual) user should

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be able not only see the world, but also then interact with the robot (real or virtual). Synchronization between both realities have to be done, e.g. when the real robot moves in the real environment, motion should be replicated in the virtual environment and so on.

This project will explore how we can better enable the development of robotics across the two realities. This environment must be realistic to facilitate immersion and therefore appeal to the state of the art in terms of VR and AR. From a technical aspect, we need to simulate autonomous robots in a virtual world using 3D renderings and realistic state-of-the-art physics engines (Unreal and Unity) and we need to use standard robotic programming environments (ROS). A prototype including such technical specifications was developed by an ENIB engineer in 2022 and can be used as part of the foundation of the project.

ENIB and UniSA are the two institutions involved in this project. Both institutions are sharing the same type of facilities that make it possible to explore shared real/virtual spaces across both universities. ENIB has 4 Pepper robots (humanoid robots) and a CAVE, plus various HMD. UniSA has a Pepper robot and a CAVE, plus various head-mounted displays for VR and AR. ENIB won first place at RoboCup@Home 2022, i.e. world champion in social robotics. UniSA is the top-level institution for AR/VR research with cutting edge hardware, software, and researchers.

Research Focus:

This project will examine how the human can control and interact with the robot across the spectrum of realities, from real world using AR, to complete simulation in VR. How do we place and represent virtual content in the robot's environment versus physical objects in the real world? This project will explore such questions, and more.

The PhD candidate will integrate the lab CNRS "IRL Crossing" (https://crossing.cnrs.fr/) that conducts original multidisciplinary research work on hybrid teams (Humans + Robots).

Supervisors:

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Research Fields: Computer Science, Virtual Reality, Augmented Reality, Robotic, Human-Computer interaction

Project 2: *Communicating virtual robotic environments in the real world*

Background:

Currently robots are developed in two separate realities: in the physical world using the real robot, and in a simulated world using a virtual robot. Using the real world allows interaction with the users, but this option can be time consuming and unsafe when testing complex algorithms (navigation, grasping …). Using a virtual world can speed up development, is safe, but breaks the natural interaction with the user. In addition, the virtual world can fail to simulate sensors/effectors of the robot and therefore differ from reality.

Mixed realities have the potential to make a "bridge" between the real and virtual worlds, taking advantage of both realities. It's advantageous to be able to develop their capabilities simultaneously across the real world, augmented reality (AR), virtual reality (VR), and robotic simulation. Using an immersive system (HMD, CAVE), a (virtual) user should be able not only see the world, but also then interact with the robot (real or virtual). Synchronization between both realities have to be done, e.g. when the real robot moves in the real environment, motion should be replicated in the virtual environment and so on.

This project will explore how we can better enable the development of robotics across the two realities. This environment must be realistic to facilitate immersion and therefore appeal to the state of the art in terms of VR and AR. From a technical aspect, we need to simulate autonomous robots in a virtual world using 3D renderings and realistic state-of-the-art physics engines (Unreal and Unity) and we need to use standard robotic programming environments

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(ROS). A prototype including such technical specifications was developed by an ENIB engineer in 2022 and can be used as part of the foundation of the project.

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Research Focus:

This project will examine how we can represent elements from the virtual and simulated environments in the real world. Given the ability for controlling robots across realities, how we do represent and communicate virtual content that the robot can virtually perceive digitally, but the human operator cannot.

The PhD candidate will integrate the lab CNRS "IRL Crossing" (https://crossing.cnrs.fr/) that conducts original multidisciplinary research work on hybrid teams (Humans + Robots).

Supervisors:

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Research Fields:

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Project 3: *Beaming: Teleporting people to remote locations using robotics and VR*

Background:

Currently robots are developed in two separate realities: in the physical world using the real robot, and in a simulated world using a virtual robot. Using the real world allows interaction with the users, but this option can be time consuming and unsafe when testing complex algorithms (navigation, grasping …). Using a virtual world can speed up development, is safe, but breaks the natural interaction with the user. In addition, the virtual world can fail to simulate sensors/effectors of the robot and therefore differ from reality.

Mixed realities have the potential to make a "bridge" between the real and virtual worlds, taking advantage of both realities. It's advantageous to be able to develop their capabilities simultaneously across the real world, augmented reality (AR), virtual reality (VR), and robotic simulation. Using an immersive system (HMD, CAVE), a (virtual) user should be able not only see the world, but also then interact with the robot (real or virtual). Synchronization between both realities have to be done, e.g. when the real robot moves in the real environment, motion should be replicated in the virtual environment and so on.

This project will explore how we can better enable the development of robotics across the two realities. This environment must be realistic to facilitate immersion and therefore appeal to the state of the art in terms of VR and AR. From a technical aspect, we need to simulate autonomous robots in a virtual world using 3D renderings and realistic state-of-the-art physics engines (Unreal and Unity) and we need to use standard robotic programming environments (ROS). A prototype including such technical specifications was developed by an ENIB engineer in 2022 and can be used as part of the foundation of the project.

ENIB and UniSA are the two institutions involved in this project. Both institutions are sharing the same type of facilities that make it possible to explore shared real/virtual spaces across both universities. ENIB has 4 Pepper robots (humanoid robots) and a CAVE, plus various HMD. UniSA has a Pepper robot and a CAVE, plus various head-mounted displays for

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VR and AR. ENIB won first place at RoboCup@Home 2022, i.e. world champion in social robotics. UniSA is the top-level institution for AR/VR research with cutting edge hardware, software, and researchers. Research Focus: This project will examine how we can teleport users to remote locations using robotics to enhance their remote control of them. Whilst the user's focus may be on the robot they are remotely controlling, the more the user feels that they are co-located with the remote robot, the greater the user's ability to control it. With the focus of controlling the remote robot, how can we teleport the user to where the robot is as effectively and realistically as possible in order to support more effective robot control? The PhD candidate will integrate the lab CNRS "IRL Crossing" (https://crossing.cnrs.fr/) that conducts original multidisciplinary research work on hybrid teams (Humans + Robots).
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3. Employment Benefits and Conditions

ENIB offers a 36-months full-time work contract (with the option to extend up to a maximum of 42 months). The probation period is two months for a contract of 37 hours of work per week.

The remuneration, in line with the European Commission rules for Marie Skłodowska-Curie grant holders, will consist of a gross annual salary of 28,596 EUR gross per year. Of this amount, the estimated net salary to be perceived by the Researcher is 1,906 EUR per month. However, the definite amount to be received by the Researcher is subject to national tax legislation.

Benefits include

- Becoming a Marie Skłodowska-Curie fellow and be invited to join the Marie Curie Alumni Association
- Access to all the necessary facilities and laboratories at ENIB and USA.
- Tuition fees exemption at both PhD awarding institutions.
- Yearly travel allowance to cover flights and accommodation for participating in AUFRANDE events.
- 10,000 EUR allowance to cover flights and living expenses for up to 12 months in Australia.
- 30 days paid holiday leave.
- Sick leave.
- Parental leave.

4. PhD enrolment

Successful candidates for this position will be enrolled by the following institutions and must comply with their specific entry requirements, in addition to AUFRANDE's conditions.

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Applicants must hold a relevant Master's degree or equivalent, and meet English language requirements: https://unisa.edu.au/research/degrees/how-to-apply/english-language-requirements/

ENIB

More information: https://www.enib.fr/en/

UniSA

Applicants must satisfy the Dean of Research that their previous education, relevant professional experience and published research work is of sufficient quality and relevance to prepare the applicant for a research degree.

Short-listed applicants will need to submit an application through the research degree application portal meet the specified requirements for the research project that is the basis of the application.

More information: https://unisa.edu.au/research/degrees/how-to-apply/

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