Project **HERON**: Intelligent Habitat coupled with Assistive Robots based on Digital Twins

Localisation: IMT Atlantique, Brest
Laboratory: LabSTICC, team IHSEV/RAMBO

1   Context

Project HERON (**H**abitat intelligent **E**t **RO**botique d'assistance basés sur le jumeau **N**umérique) is part of the bilateral research program "*Chaire Maintien à Domicile (M@D)*", jointly directed by the Foundations of ENSIBS[1] and of IMT Atlantique[2] with a strong collaboration of the Kerpape rehabilitation centre[3]. Its goal consists in conceiving and testing systems using new technologies allowing frail or disabled people to palliate the loss of personal autonomy and in turn, prolong their potential for continual living in their homes. Our society is increasingly confronted with this challenge as a result of its demographic change, induced by increasing ageing and birth rate decline.

2   Objectives

In this context, the team IHSEV/RAMBO of IMT Atlantique collaborates with team MOCS of ENSIBS to develop novel assistive services, offered by service robots that operate within smart spaces/environments. The project HERON aims to develop a cyber-physical model of a system consisting of (i) *the human user*, (ii) the *intelligent habitat* and (iii) the *assistive robots*, on the basis of the notion of "Digital Twin" (DT) for each of these constituents. Establishing this dual relation between the real world and its replicas in the form of DTs will serve as reference point, on the basis of which different assistance services could be developed, allowing to **monitor**, **diagnose** and **forecast** the behaviour of the entire system.

Inspired by the exploitation of DTs in the domain of Industry of the Future and Internet-of-Things, the project HERON extends this perspective in the domain of personal assistance.

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[1] https://www-ensibs.univ-ubs.fr/fr/index.html
[2] https://www.imt-atlantique.fr/en
[3] http://www.kerpape.mutualite56.fr/

3 Research and Development

The tasks to be pursued concern the definition of the characteristics and of the processes that operate on the state of the human user and its environment, namely, the smart home and the assistive robots.

This implies an initial constitution of the DT of a smart home (in particular, the *LivingLab* of IMT Atlantique and its equivalent in ENSIBS), followed by the DTs of mobile robotic manipulators operating within them (e.g. TurtleBot2i, Robotnik RB-1, Pepper robot, etc) and finalized by the DT of a human user. This order of progression will be followed in order to start off with a highly constrained setting and gradually advance towards a more probabilistic treatment. For each constituent of the entire system (home, robots and human), a corresponding ensemble of services will be made available by enriching those already existing or by introducing new instances, as part of the triad **monitoring**, **diagnosing** and **forecasting**. Examples include, but are not limited to: human activity recognition, semantic environment mapping, detection of irregularities, proactive assistance, automated maintenance, etc.

At the technical level, development will be performed using the Gazebo simulator environment[4], the Robot Operating System ROS [5] and the home automation interoperability protocol xAAL[6] developed by the team of IMT Atlantique. To model the various states and tasks being performed, the use of the planning framework ROSPlan[7] or Smach[8] will be evaluated before final deployment. To determine the technological readiness of the developed work, the digital twins of the two living labs will be made accessible and tested through remote terminals (cf. Gazebo-Web[9]).

4 Project perimeter

Funding   HERON is a 1.5 year (18 months) project, jointly funded by the Brittany Region under the program SAD 2019 (Strategy for Durable Development), the Department of Finistère under the program ARPE (Aid to Emergent Research Program) and the Chaire M@D (Maintien en Domicile). The postdoctoral employment contract includes the candidate's remuneration, full social security coverage as well as funding for conference participation and partner meetings.

Localization   The hosting facility for the post-doctoral researcher is the IMT Atlantique Bretagne-Pays de la Loire (Brest campus), a public institute of superior education (postgraduate) and research, that accredits Master diplomas to engineers up to Doctoral degree.

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[4] `http://gazebosim.org/)`
[5] `http://wiki.ros.org/)`
[6] `http://recherche.imt-atlantique.fr/xaal/`
[7] `https://kcl-planning.github.io/ROSPlan/`
[8] `http://wiki.ros.org/smach`
[9] `http://gazebosim.org/gzweb.html`

Lab   The IHSEV/RAMBO research team specialises in information and communication technologies for assistance to people, combining skills from informatics and robotics: service robotics, robotic learning and vision, domotic protocols and interactive TV. The team disposes state-of-the-art robotic equipment (mobile robots (TurtleBot2 and variants), humanoids (RB-1, Pepper), robotic arms (Kinova, e.DO), offering an attractive working environment for hosting research activities of international visibility.

5   Candidate profile

General conditions: Holder of PhD Degree in the domains of Robotics, ICT or associated field. Fluency in English is required, a spirit of collaboration and of initiative in the face of technological challenges. Knowledge of French is appreciated but not mandatory. Publications to relevant highly-ranked conferences and/or journals in the associated fields is a pre-requisite.

Eligibility conditions: In accordance with the SAD 2019 program of Brittany region, prospective candidates should have performed a minimum of a 18 month long stay abroad, in the period between the 1st of May 2016 and the starting date of the project (recruitment day).

Theoretical skills: Experience in two or more of the following domains: *Robotic architectures, smart factory, system programming, client-server architectures, calibration, 3D graphics.*

Technical skills: Experience in the following technologies/tools: *Robot Operating System (ROS), Object-oriented programming Python/C++, scientific computing, 3D simulation environments*

The interested candidates should provide the following:

- CV

- Motivation letter

- List of publications

- Letters of recommendation (or list of referees).

The post-doctoral researcher will be jointly supervised by Ass. profs **Panagiotis Papadakis** and **Christophe Lohr**. To candidate for the position, please send your application to the following e-mail:**application-heron@imt-atlantique.fr**

The position is immediately available and applications are receivable until the position is filled.