ERL Consumer Service Robots
Test Bed Certification

ECHORD++'s RIF @Peccioli

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Test bed name: ECHORD++'s RIF @Peccioli

Test bed web page URL: www.peccioliri f.com

Name of Institution where test bed is hosted:
the BioRobotics Institute, Scuola Superiore Sant'Anna, Italy.

Designation of the lab/department/group where test bed is located:
Assistive Robotics Lab, the BioRobotics Institute, Scuola Superiore Sant'Anna, Italy.

Name of responsible person:
Filippo Cavallo

Contacts of responsible person:

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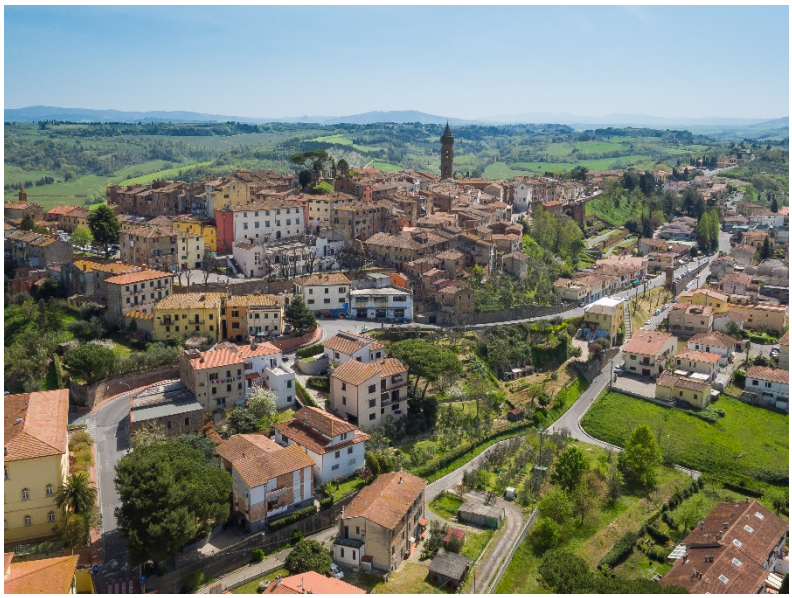
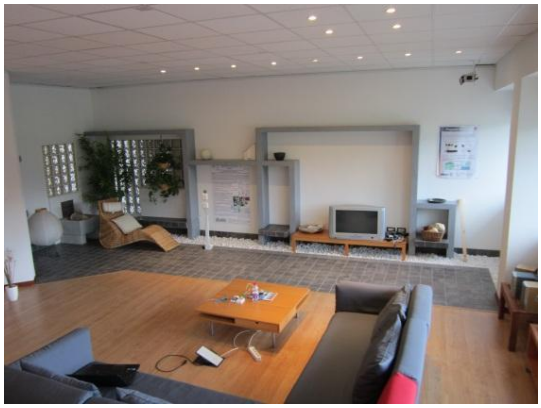
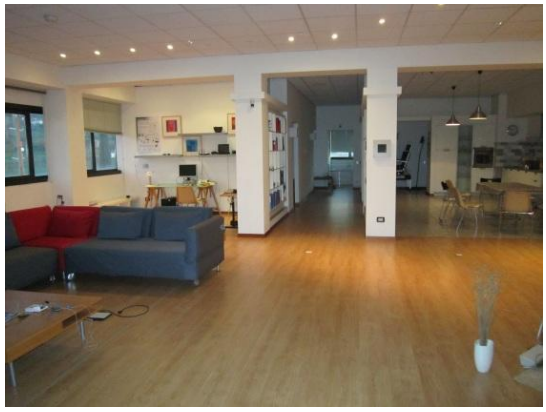
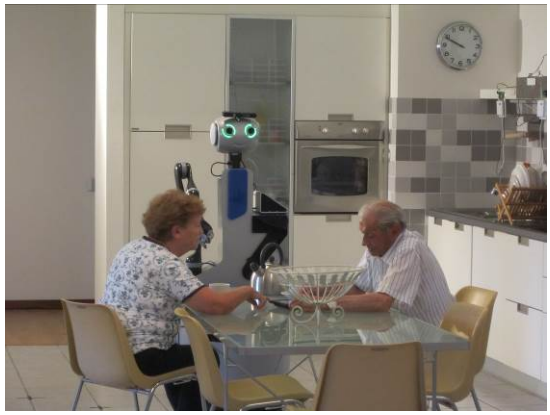
Pictures with overview of the test bed





Short description of the facility, including the type of furniture used, wall materials, available objects and robot platforms

Peccioli RIF facility is a real apartment suitable for some ERL-SR TBMs and FBMs (as indicated below). The walls are solid walls (not movable) and the apartment includes one main entrance door, some doors to access the rooms and several open spaces. The apartment contains typical furniture, such as tables, chairs, sofa, bookshelves, beds, kitchen furniture and kitchenware, plants, a TV set etc. A technical room is also present. In this room some PCs and monitors are available to monitor and guide the benchmarks. A wireless network is also available in the apartment. Other (portable) devices not present at this moment can be added, including a Motion Capture system mounted on stands, as it was done for the RoCKIn Camp 2015.

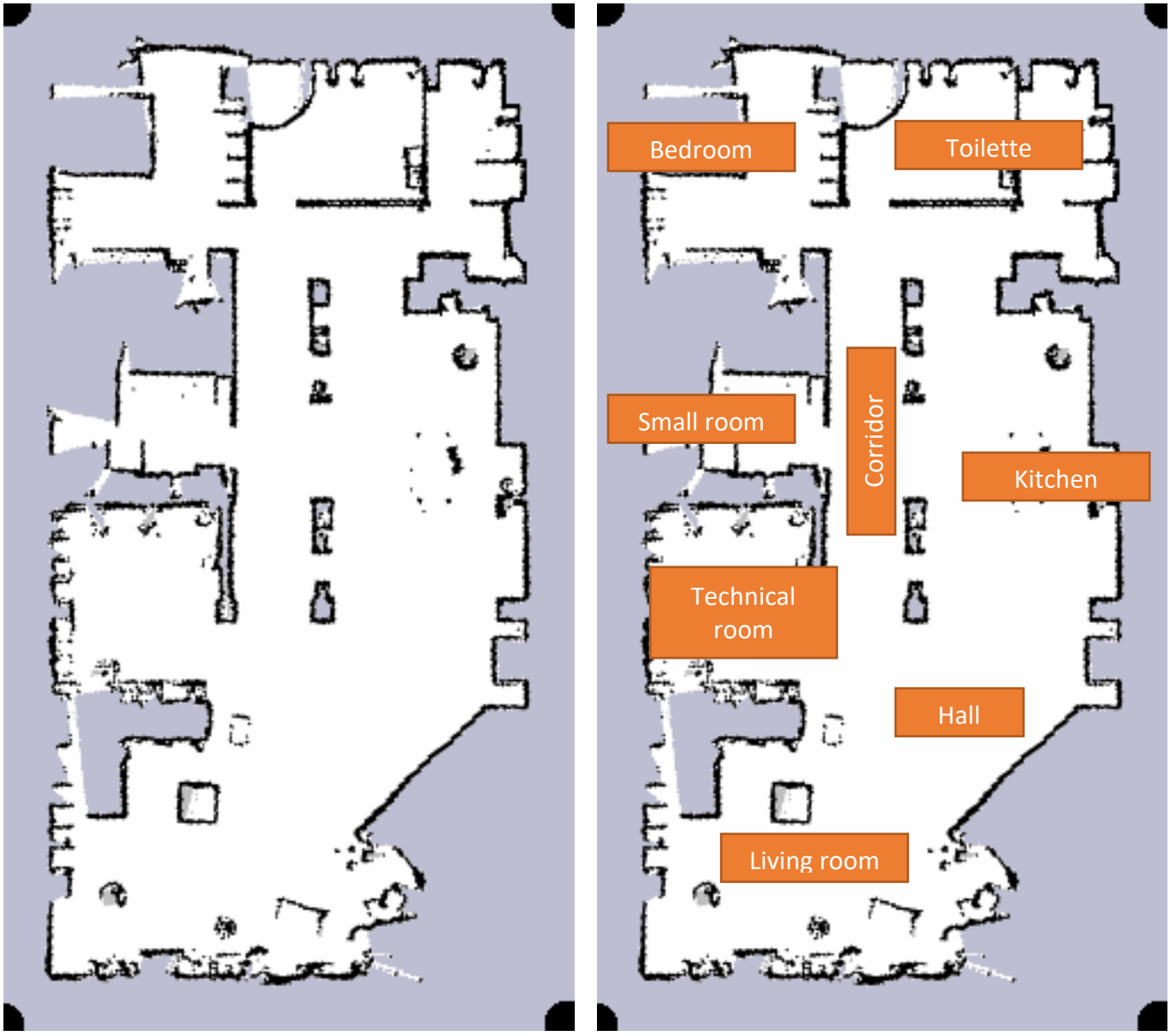
The sensors placed in the home environments are based on a ZigBee-Pro low-cost, small form factor, general purpose radio module. The same boards are used to compose both the sensor network for the environmental monitoring and for the user localization network, depending on the firmware uploaded, see Sec. IV. In particular, the Ember ZNet ZigBee-pro stack is used as communication stack for these two networks. The board sensors and its functional parts are shown in Fig. 3. Each board is equipped with a CEL's MeshConnect™ EM357 Mini Modules (CELL, USA), that is composed of a ZigBee radio module and a power amplifier to extend the radio range. The power management system allows to power the board from a 5V DC plug or a USB micro-B port while a Li-Ion battery is used for power back-up. A dedicated microchip is embedded to recharge the battery and act as emergency power system. Three sensors is

embedded for environmental monitoring: a digital temperature sensor, an analogic humidity sensor and a digital light sensor. An external antenna connector allows to plug sectorial antennas to spot specific workspace areas, improving the localization accuracy. A pin header provides connection to six GPIO ports, power supply and ground to plug external sensors like PIRs and switches.

Finally, the facility includes also a domestic Wireless Sensor Network (WSN), constituting an Ambient Intelligence (AmI) infrastructure, that supervises the home and localize the user. Other agents of the system include the elevator and the user interface sub-system (i.e. tablet and microphone).

Test bed layout, including dimensions, areas and room designations

A map of Peccioli Apartment is depicted below, as a metric map and with functional areas.

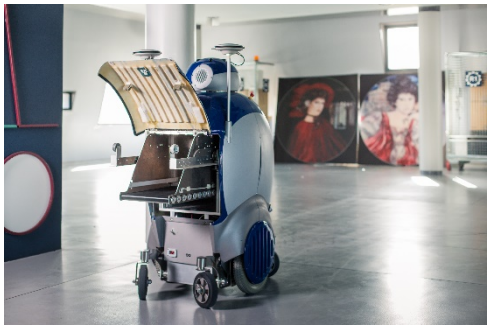


List of home automation devices available, including photo, make, model and main features:

Doro and Coro

Nao

Coro



Oro

The DomoCasa Lab places itself as a complete and integrated laboratory for testing frontier research in the field of robotics and AAL, attracting people to give their own contribution for experimentation and new results. Inside the House-Lab, thanks to the presence of engineers from the bioengineering laboratories of the Scuola Superiore Sant'Anna, innovative criteria and approaches for technical and functional validation are defined to measure – through actual use of the house – the level of usability and acceptability of the domotic devices and systems and, more in general, the entire "home system".

DORO/CORO robots: The domestic robot has to safely navigate in a domestic environment. It mounts a front laser (SICK S300) and a rear laser (Hokuyo URG-04LX) in order to have a 360° field of view, to be able to avoid obstacle and for self-localization. A Kinova Jaco link arm is used for manipulation tasks. The head of the robot has a pan-tilt unit, an Asus XtionPro and high resolution cameras used for object detection. Multicolor LEDs, mounted on the eyes, and speakers provide a feedback to the user. The robot brings a removable tablet that user can use for service Requests. The condominium robot has to navigate between floors through the elevator. Most of the hardware is shared with Doro. It does not have an arm, but it mounts a roller mechanism in order to be able to exchange goods with the DustCart.

ORO robots: outdoor robot which is an autonomous mobile robot designed to transport objects in urban environment. The robot consists of a mobile base, a container for the objects, a robotic head and a touch screen used primarily for human-robot interaction and sensors for obstacle detection and localization. The mobile base consists of a mechanical chassis with two central actuated wheels (Swissdrive 400 T hub motor with electromagnetic brake and encoder by Micro-Motor AG) and four passive rear wheels with shock absorbers.

KUBO robot: It is a Kuka Youbot platform addressed to be used as mobile table inside the house. It has Maximal freedom of movement (x, y, Θ) with the omnidirectional wheel system. The KUKA youBot platform is ideal for research, education and application development especially in the field of logistics and navigation, whether for motion planning, autonomous driving or feasibility studies. With open interfaces – simply extended with sensors or actors – and equipped with an integrated controller PC, it is possible to work on a broad spectrum of topics.

NAO robot: an autonomous, programmable humanoid robot. He feature an inertial measurement unit with accelerometer, gyrometer and four ultrasonic sensors that provide him with stability and positioning within space. The legged versions included eight force-sensing resistors and two bumpers.

UNIVERSAL ROBOT: a collaborative robot that easily can be integrated into existing production environments. With six articulation points, and a wide scope of flexibility, the collaborative robot arms are designed to mimic the range of motion of a human arm.

KINOVA Arm: a robotic arm that has been used for Service and Assistive Robotics. It has the following features: Weight 4,4kg, Payload 2,6kg (mid-range), Reach 900mm, Power Consumption 25W average.

Available Motion Capture system (make, model, and main features)

Not available.

Current list of TBMs and FBMs for which the test bed is certified

(i.e., meets both the rulebook specifications and has available the required devices).

Benchmark	Minimum required system / devices	Available in Test Bed
TBM1: Getting to know my home	RSBB	YES
TBM2: Welcoming visitors	RSBB, IP camera at entrance	
TBM3: Catering for granny Annie's comfort	RSBB, HAD	
TBM4: Visit my home	None	YES
TBM5: General purpose service robot	None	YES
FBM1: Object perception functionality	RSBB, MoCap	
FBM2: Navigation functionality	RSBB, MoCap	
FBM3: Speech recognition functionality	None	YES

Table 1: List of the ERL Consumer benchmarks with their corresponding required systems