robots @ home

# *An open Platform for Home Robotics*

PROJECT SUMMARY

The objective of robots@home is to provide an open mobile platform for the massive introduction of robots into the homes of everyone. The groundbreaking innovations are: (1) A scaleable, affordable platform in response to the different application scenarios of the industrial partners: domotics, food delivery, and elderly care. (2) An embedded perception system providing multi-modal sensor data for learning and mapping of the rooms and classifying the main items of furniture. (3) A safe and robust navigation method that finally sets the case for using the platform in homes everywhere. The system is tested in four homes and at a large furniture store, e.g., IKEA. Developers as well as lay persons will show the robot around, indicate rooms and furniture and then test the capabilities by commanding to go to the refrigerator or dining table.

The scenario-driven approach is inspired by recent work in cognitive science, neuroscience and animal navigation: a hierarchical cognitive map incorporates topological, metric and semantic information. It builds on structural features observed in a newly developed dependable embedded stereo vision system complimented by time-of-flight and sonar/infrared sensors. This
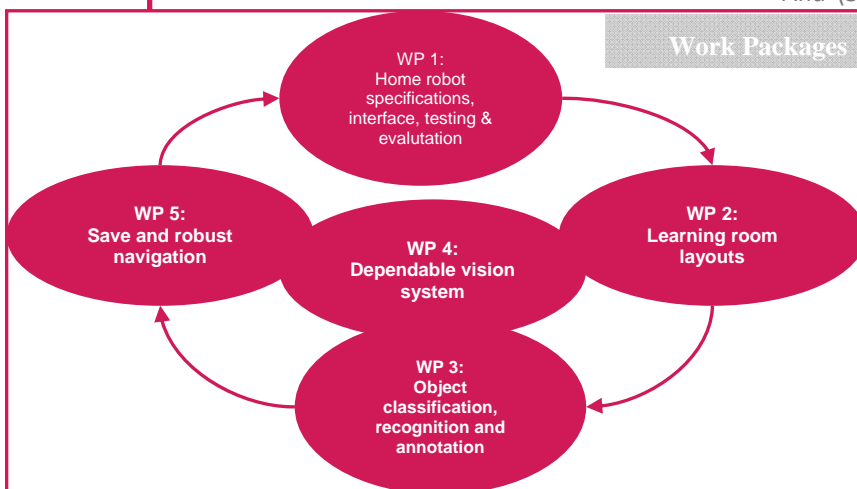
PROJECT OBJECTIVES

The emphasis is on providing easy-to-use modules that enable robot navigation in everyday human environments. The breakthrough is based on three main innovations. (1)

James @ IKEA
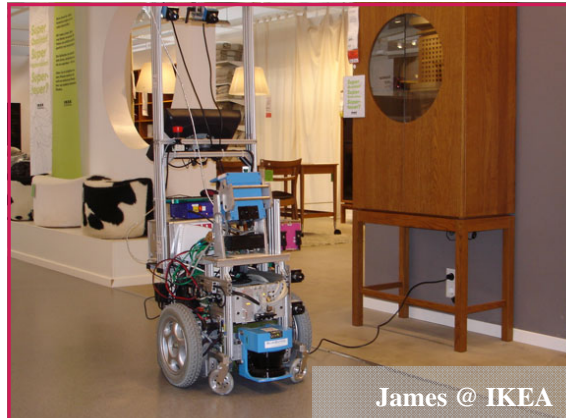
The basic mechanical module as a scaleable mobile platform in response to the several and different application scenarios such as security, facility management, care, service and personal robotics. (2) A dependable and embedded perception module provides a multi-modal set of sensor data for learning and mapping of the rooms and navigation through the environment. And (3) the development of a safe and robust navigation method finally sets the case for using the platform in homes everywhere. Finally, perception, action and navigation are integrated and tested in typical home environments specified by the industrial end users and in a furniture warehouse, e.g., IKEA. Developers as well as lay persons will show the robot around, indicate rooms and main items of furniture, give the robot time to investigate and certify the map, and then test the capabilities by commanding it to go, e.g., to the refrigerator, the dining table, or the bath tub.

It is the intended goal of the partners that the results of the robots@home project lead to a rapid introduction of the robots@home platform into commercial domestic robots and mobile service robotic systems. It will serve as an afford-

Work Packages

- **WP 1:** Home robot specifications, interface, testing & evaluation
- **WP 2:** Learning room layouts
- **WP 3:** Object classification, recognition and annotation
- **WP 4:** Dependable vision system
- **WP 5:** Save and robust navigation

solution will be developed along three progressively more challenging milestones leading up to a mobile platform that learns four homes, navigates safely and heads for at least ten annotated pieces of furniture.

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EXPECTED RESULTS

robots@home sets out to realise the necessary methods and modules for closing the existing technological gaps:

- Safe navigation method scaling to the diversity of home settings with many rooms, many items of furniture, many obstacles and high clutter,
- Robust perceptual and processing methods enabling to move from 2D navigation to coping with 3D structures and providing the capability to classify these structures,
- Embedded stereo vision system (ESVS) targeted for in-door usage providing dependable and dense stereo data at camera frame rate complementing sensing modalities such as intensity, colour, omni-vision, time-of-flight depth images and sonar sensors,
- Simple user interface for showing the robot around to obtain the room map and to annotate main items of furniture in the rooms, and
- Sizeable platform design and hardware ready to tackle the everyday home conditions.

To achieve these goals the consortium integrates research and commercial know how from recent developments and ongoing ground-breaking research work in a scenario-based approach (see Section 7).

The envisioned solution is inspired by recent work in cognitive science, neuroscience and animal navigation: a hierarchical cognitive map incorporates topological, metric and semantic information. It builds on structural features observed in a newly developed dependable embedded stereo vision system and complimented by time-of-flight and sonar sensors.

The "robots @ home" project

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Partners:

- ACIN TU Wien
- Eidgenössische Technische Hochschule Zürich
- Austrian Research Centers GmbH
- BlueBotics SA
- Legrand SA
- Nestlé Nespresso SA
- Otto Bock HealthCare GmbH

Duration:
May 2007— April 2010

Total cost:
Budget: EUR 3,3 Mio.
Funding: EUR 2,278 Mio.

Further information:
www.acin.tuwien.ac.at

Typical scenarios where the robots@home platform must navigate safely: table with protruding, chairs with slanted or thin metal legs, toys, largely open balustrades, open space under a tilted roof, etc.