Ambient Assistive Home Environments

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Abstract
All modern industrialized countries are confronted with a series of mega trends that affect the way we will live in 2019, e.g. demographical changes and resource efficiency. This position paper envisions opportunities and challenges for Architectural Robotics to meet resulting demands. It focusses on typical living environments, i.e. private and residential homes.

Keywords
Ambient Assisted Living, Architectural Robotics, Engineering Challenges

Introduction
All modern industrialized countries are confronted with a series of mega trends that have already become social and economical challenges. Among the most obvious ones are (i) demographical, structural, and social changes, which result in an increased need for ICT-based assistance in daily life (aka. Ambient Assisted Living [1]), (ii) the increasing pervasion of information and communication technology, which demands more proactive assistance, and (iii) the growing relevance of resource saving (e.g. water, engery) and energy harvesting. In this *extended abstract* we envision opportunities and challenges for Architectural Robotics (AR), i.e. intelligent and adaptable physical environments, to meet the demands raised by the aforementioned mega trends. We put a focus on typical living environments, i.e. private and residential homes.

Ambient Assistive Home Environments
Promising assistance scenarios for AR in private and residential homes comprise:

- Based on the current usage situation, walls move themselves to increase or decrease the size of the room. E.g. if only one inhabitant is there, the rooms size is reduced to reduce required heating energy, and surfaces to be cleaned, in case of presence of guests the room size is increased.
- Virtual windows consisting of thin film display internally and cameras externally allow to move the windows on the walls like a picture frame. This enables the varying layout of rooms.
- Smart floor cushions sudden falls. Typically it is hard as stone to enable safe movement, but can become immediately very soft. It also detects gait changes and suspicious movement patterns.
- Situations of helplessness can be detected from the environment by means of ambient sensors.
- The dwelling is able to protect itself and the inhabitants, by extinguishing fire, e.g. on the oven, switching off dangerous resources, e.g. water, gas.
- Household appliances automatically change their arrangement based on the location of the different users. E.g. kitchen appliances are moved down, if the wheel chair user wants to use them.
- Bed lowers its height in case of potential fall out of bed.
- While lying on the bed or couch, the muscles can be trained by external stimuli and force feedback. This helps to keep the people's strenghts as long as possible.
- The home environment can coach the inhabitant thus the daily routine, by suggestions and reminders.
- Chairs, couches and beds support the persons with standing up and sitting down by changing the height and their horizontal inclination.
- By means of rotating or reshaping, the house is able to harvest and save energy and control the climate in it. It controls the opening of windows or walls.
- Virtual windows, that allow to look through the walls prevent the loss of energy.

Engineering Challenges

Besides the technical feasibility of the solutions, final success of AR depends to a large extend on how it meets the following challenges and required system qualities:

The services and the required technical installation and resources must be affordable and there must be means to allow sharing of costs between different stakeholders (inhabitants, insurances, public bodies). The system must support its seamless extension and interoperability by new devices and services in the field in order to adapt the system to changing demands of the inhabitants over time. The solutions must be robust against all kinds of misuse and errors and the services must be available even in the presence of hardware component crashes and shortage of resources. Furthermore, the systems should preserve the safety of the assisted persons and not harm them. Despite the continuous monitoring of persons, the solutions must guarantee a well defined degree of security and privacy for the persons under surveillance. The system must be comprehensible and thus trustable for the end users, they are especially interested in how access is granted to which of their information in what situation.

Clear business cases are required for a sustained industry engagement. This includes a clear understanding of the user's demand and the contribution or value of the solution. A central issue is to find a clear financial motivation for the provision of the various system components that can be integrated. Furthermore, public bodies, e.g. health insurance systems, must accept the solutions as viable alternatives to conventional assistance.

References

[1] http://en.wikipedia.org/wiki/Ambient_Assisted_Living