Cloud Networked Robotics Technologies for Super-Aging Society

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In the near future, robotic services are expected to be important factors to support daily activities, particularly for such super-aging societies as Japan. These societies face a critical social problem: encouraging the social participation of elderly people, especially those who are living alone or who require nursing care. In this context, robotic services are expected to provide elderly people with necessary care from the viewpoint of both physical and mental support [1].

To solve the problems related to super-aging societies, various robotic services must be deployed in real world environments, in which such components as sensors in environments and smartphones acting as sensors or interfaces have been incorporated with standalone robots and then service applications organize them to provide services. Developers must consider how to provide services using different kinds of robots, because appropriate robot hardware varies depending on user abilities and preferences [2].

Cloud Networked Robotics, a new field of research tackles this problem by abstracting robotic functionalities and providing a means for utilizing them. We have proposed the Ubiquitous Network Robot Platform (UNR-PF) as a common infrastructure for cloud networked robotics with several standardization activities and reference implementation as open source software [3].

Since the UNR-PF focuses on robotic services, it should face with two different problems: firstly, it should provide a *common framework* for robotic services and robotic components, and simultaneously it should support execution of *service specific functions*, which are provided by robotic components and requested from robotic services. To solve these problems, the UNR-PF architecture relies on the RoIS (Robotic Interaction Service) international standard [4], which is proposed from OMG (Object Management Group) considering several service robots and robotic services including our projects.

Though RoIS provides definitions of 15 basic HRI (human robot interaction) components for interaction services, it obviously cannot cover wide-ranging fields of robotic services such as life support services for super-aging society. RoIS therefore provides means to extend them by describing user defined HRI components. Definition of such components and their functional requirement should be obtained from observations in real environments and evaluated through field experiments. While developing such services using a common platform, the requirements will be described and shared as (specific) component profiles, and on the other hand knowledge about the services will be organized using those requirements as vocabularies in relation with standards of Ambient Assisted Living (AAL) and healthcare frameworks.

A case study was conducted for factoring out knowledge components and representing them explicitly in a formal knowledge base [5]. A robotic recommendation service in a shop environment [6] was re-implemented by bridging two cloud networked robotics projects, using RoboEarth [7, 8] as knowledge representation and service application layer and UNR-PF as distributed robotic platform layer.

Another case study in nursing home environment proposed two robotic services [1]. One uses semi-autonomous wheelchair robot to transfer elderly people in the environment to reduce workload of caregivers and to increase autonomy of transportation of elderly people. Another uses range sensors in the environment as a fall-detection system. The definition of the system components and possible extension to the RoIS specification is being discussed in OMG [9] and the evaluation of the robotic service will soon be presented in HAI2014 [10, 11].

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