Chapter 11
A Modular Structured Architecture Using Smart Devices for Socially-Embedded Robot Partners

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ABSTRACT

Recently, robot architectures with various structures have been developed to improve the human quality of life. Such a robot needs various capabilities such as learning, inference, and prediction for human interaction, and such capabilities are interconnected with each other as a whole system. In the development of a socially-embedded robot partner, human-robot interaction plays an important role. Therefore, in order to develop a socially embedded robot partner, we must consider human communication system. Human Cognition, Emotion, and Behavior should be considered in the development process of the robot partner, and if these factors are fully reflected in the robot partner, then the robot can be used as a socially-friendly robot partner. This book chapter is organized as follows: First, we describe the hardware and software structures. Next, we discuss the cognitive model of the robot partners. Third, we discuss interaction content design for various services. Finally, we discuss the contents of society implementation, and discuss the applicability of robots for social utilization.

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INTRODUCTION

In recent years, the number of elderly people living alone has been increasing, and various social problems have arisen. For example, elderly people who are living alone without medical or social support have difficulties in providing care for themselves. In fact, the problem of lonely death is a social problem in Japan. In order to solve these social problems, the introduction of coexisting human-friendly robot partners is one of the possible solutions to realize robot elderly care support. In addition to support for the elderly people, robot partners are being developed for various parts of daily life based on the background of personal robot industry development. Besides that, the remarkable growth of mechatronics in accordance to that has also contributed to the improvement of human life quality (Alfred et al., 1990; Takahiro et al., 2017; Renteria-Bilbao et al., 2019; Broadbent et al., 2009; Tang et al., 2015; Sheridan et al., 2016; Habib et al., 2008).

In robotics, in order to improve the quality of life of humans, various robots are developed by using social robot technology (Esposito et al., 2016; Woo et al., 2012). Social robots can communicate with people by combining network technologies such as artificial intelligence, Internet of things technology, and cloud computing, which are becoming technologically advanced recently. Therefore, in order for these robots to be put to practical use, social behaviors and interactions should be studied so that they work well in human society (Lemaigan et al., 2017).

Conventional robots moved by using sensors to detect obstacles in the environment. However, in the case of social robots, it is necessary to interact not only with the obstacles present in the environment, but also with human conditions (So et al., 2018). In order to take full account of these factors, there are many researches on cognitive models of robots that imitate human cognitive models (Breazeal et al., 2002). Cognitive model is composed of cognitive architecture and knowledge to take a behavior (Howes et al., 1997). Among them, a typical cognitive architecture is the “Subsumption Architecture” by Rodney Brooks (Brooks, 1986).

In the case of human interaction, Piaget’s theory of cognitive development suggests that human cognitive development is an adaptation process that is made by interaction with the environment, and that it develops through several steps (Piaget et al., 1964). Robots living with humans also need to learn and develop by interacting with the environment in accordance with human learning rules. Therefore, various cognitive models of the robot have been discussed (Khamassi et al., 2011; Burghart et al., 2005). Here, we have developing robot partner system based on a modular cognitive model (Woo et al., 2017).

In this paper, we describe from the hardware modules to the software modules of the robot, explain the cognitive model for constructing the social robot, and explain the system integration according to modular structure of robot partner.

This paper is organized as follows: Section 2 explains the development of robot partners. This section describes the robot’s hardware and software modules. Furthermore, we explain the system integration using each module. Section 3 explains interaction design for social implementation. Here, we describe the interaction contents design of the robot that is configured to make it easy to create, maintain, and manage the contents necessary for the human-robot interaction. Section 4 describes several examples of the proposed methods to social implementation using robot partner system. Section 5 concludes this paper, and discusses the applicability of the proposed method and future direction of this research.
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