Chapter 7
Human-Robot Interaction Design Using Smart Device Based Robot Partner

Jinseok Woo
Tokyo Metropolitan University, Japan

Naoyuki Kubota
Tokyo Metropolitan University, Japan

ABSTRACT

Nowadays, various robot partners have been developed to realize human-friendly interactions. In general, a robot system is composed of hardware modules, software modules, and application contents. It takes much time to design utterance contents and motion patterns as application contents simultaneously, but the design support systems mainly focus on the generation of robot motion patterns. Furthermore, a methodology is needed to easily change the specification of hardware and software according to diversified needs, and the developmental environment to design the application contents on verbal and nonverbal communication with people. In this paper, the authors propose robot partners with the modularized architecture of hardware and software by using smart devices, and propose a developmental environment to realize easy contents design of verbal and nonverbal communication. In order to solve the problem of difficulty in the content design, they develop a design support environment using design templates of communication application contents. Next, they apply the robot partner to navigate visitors to the robot contest of the system design forum held in Tokyo Metropolitan University. Finally, they show several examples of the interaction cases, and discuss the interaction design for smart device based robot partners.

1. INTRODUCTION

Recently, various types of robot partners have been developed to realize natural interaction with humans. Several researchers are interested in the development of social robots for improving the quality of life (Fong et al., 2003; Wu et al, 2012). Social robots require human-like natural communication capability. Human-like communication capability has been discussed in the research field of human-robot interaction

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such as motion planning cognitive models, and theory of mind. The study on cognitive robotics mainly deals with human-like intelligence on total cognitive mechanism such as cognitive development, behavior acquisition, and social communication based on constructivism. The research on cognitive development is to investigate the theory and essence of the primitive stage of human cognitive development by using robots based on constructivism. The research on behavior acquisition is to investigate the theory and methodology for human-like behavior acquisition, e.g., imitative learning and social learning. The research on social communication is to investigate the theory and methodology on human-like natural communication by using robot partners where sometimes knowledge database and behaviors for social interaction is given to robot partners.

Social robots have been applied in the field of health care. MIT Media Lab has developed Autom for personal diet coach (Kidd et al., 2007). Users can interact with the robot through a touch screen, and the robot can advise information about food and exercise using a Text-to-Speech system. The robot helps maintain the user's diet plan in a more convenient way. Furthermore, social robots have also been used for family interaction. JIBO has been developed focusing on the interaction with human (Guizzo, 2014). The robot has one touch screen and three actuators; it can track the human face using two cameras. The users can also communicate with their family by using a telepresence system. Humanoid type of social robots has also been developed for human-friendly communication. Pepper is designed to consider human emotional state to communicate with robot. The robot is implemented to give an enriched customer experience in the business area (Brown, 2014). PALRO has been developed by FUJISOFT (Woo et al. 2013; Inoue et al., 2014; Ono et al, 2015) in order to conduct information support for elderly people.

In general, a robot system is composed of hardware modules, software modules, and application contents. Despite the intensive research interest on robot partners, the task-oriented customization of hardware and software of robot partners according to the aims and environmental conditions of users significantly takes much developmental cost and time. For example, PALRO has 20 degrees of freedom. It is also equipped with various sensors such as gyro, accelerometer, infrared LED, camera, microphone and speaker. Basically, it is difficult to change the hardware components of PALRO according to a different aim. Therefore, we have discussed the applicability of smart device to robots in order to reduce developmental time and cost of a robot partner. Since many smart devices have been developed with the implementation of high quality sensors and processors, the operations requiring high performance can be simply handled by utilizing a high-performance smart device. And the built-in sensors can provide accurate measurement for the robots. Furthermore, since smart devices are used actively in developed countries as well as in developing countries (Google & Ipsos MediaCT, 2015), we can promote the development of such smart device based robots. Furthermore, the system integration based on modularization is very important in order to facilitate social implementation while reducing development time and cost. I propose a modularized architecture of robot partners using smart device to realize the flexible update based on the reusability of hardware modules and software modules. Especially, I focus on the easy hardware design of robot body with two arms by using 3D printers, and the easy implementation of applicable software libraries.

In order to popularize the business on robot partners, we have to discuss the design of application contents by considering the difference among vendors, customers, and users. When a vendor sells a robot partner, the vendor is expected to prepare the utterance contents to meet the expectation of users. Thus it would be better to customize utterance contents easily by combining several utterance contents packages. The vendors are commonly well trained to customize the property of robot partners. However, a customer unfamiliar with the development of robots may have to design utterance contents accord-