

氏名	禹 ^ウ 珍碩 ^{ジンソク}
所属	システムデザイン研究科 システムデザイン専攻
学位の種類	博士(工学)
学位記番号	シス博 第86号
学位授与の日付	平成29年3月25日
課程・論文の別	学位規則第4条第1項該当
学位論文題名	Socially Embedded Robot Partners with a Modular Cognitive Model (モジュール的認知モデルを用いた社会実装型ロボットパートナー)
論文審査委員	主査 教授 久保田 直行 委員 教授 山口 亨 委員 准教授 和田 一義 委員 教授 今井 倫太(慶應義塾大学)

【論文の内容の要旨】

Recently, various types of robot partners have been developed to realize social interaction with people in daily life. A robot partner requires a cognitive model like human being to conduct social interactions. Various types of cognitive models have been proposed in psychology and cognitive science. For example, a simple cognitive model based on subsumption architecture has been successfully applied to easy tasks, but it is difficult to apply those kinds of cognitive models practically to social applications based on human interaction. Furthermore, we need a methodology to easily change the specification of hardware and software according to diversified needs, and the developmental environment to design the contents on verbal and nonverbal communication with people. The system integration based on modularization is very important in order to facilitate social implementation while reducing development time and cost.

This thesis proposes robot partners with a modular cognitive model based on modularized architecture of hardware and software, and proposes a developmental environment to realize easy contents design of verbal and nonverbal communication. First of all, 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. Next, I propose a modular cognitive model composed of cognitive system, emotional system, and behavioral system to easily realize social interaction with people. Next, in order to solve the problem of difficulty in the content design, I develop a design support environment using design templates of communication contents based on the proposed modular cognitive model. Finally, I conduct preliminary experiments on the integration of robot partners based on the modularized architecture by different sets of hardware modules and software modules. Furthermore, I discuss the effectiveness of the proposed modular cognitive model for robot partners through social implementation and experiments in addition to the development of communication contents using design templates.

This thesis consists of six chapters described as follows.

Chapter 1 gives the introduction of this thesis. First, I present the social and research background related with this thesis. Next I explain the aim and the overall organization of this thesis.

Chapter 2 shows the technical background and recent progress on robot partners and their applications.

Chapter 3 explains the modularization of hardware and software, and proposes a modularized architecture of robot partners using smart devices. First, I define the basic specification of robot body and arms in order to design the shape according to the target aim, and propose various types of robot partners using different degrees of freedom. Next, I propose a modularization method to easily change and update the combination of software modules such as voice recognition and image processing according to the detail of services requires to a robot partner.

Chapter 4 proposes a modular cognitive model based on the modularized architecture of hardware and software explained in Chapter 3. First, I discuss the minimal combination of system modules in the cognitive architecture required for the social implementation. The modular cognitive model is composed of cognitive system, emotional system, and behavioral system to easily realize social interaction with people. Each system module works independently. Since these system modules are mutually interconnected and coupled, the robot partner can conduct human-friendly communication dependent on the emotional system and behavioral system by communication contents. I discuss the effectiveness of the modular cognitive model from the various points of view, and show the proposed method through the social application.

Chapter 5 proposes a design support environment of communication contents based on modular cognitive model of robot partners. First, I propose design templates for easy design of communication contents. Next, I apply the proposed design templates to communication contents for demonstration of robot partners at events on exhibition halls and robot contests. Experimental results show that contents designers unfamiliar with the robot development can develop communication contents by using the design templates according to the guideline. Next, I apply the proposed system to elderly care by robot partners. Furthermore, I show several examples of the easy customization of communication contents according to the different aims, and discuss the applicability of the proposed system in social implementations.

Chapter 6 concludes this thesis and discusses future works on the solution.