Chapter 4
Repository-Based Multiagent Framework for Developing Agent Systems

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ABSTRACT
Agent systems have been designed and developed using recent agent technologies. However, design and debugging of these systems remain as difficult tasks of designers because agents have situational and nondeterministic characteristics and because any useful design support facilities have not been provided for designers. To raise the efficiency of the agent system design process, we propose an interactive design method of agent systems founded on an agent-repository-based multiagent framework that emphasizes an important feature of agent design: the use and reuse of existing agents from an agent repository. We propose an interactive design environment of agent system (IDEA) and demonstrate its effectiveness.

INTRODUCTION
Using recent Information and Communication Technology (ICT), people can get much information from Digital Spaces (DSs) such as the internet. Useful workspaces or communities can be constructed in a DS as well as in a Real Space (RS) in the physical world. ICT changes the traditional society to modern networked societies where people can exchange information and knowledge freely and easily. However, emerging problems are apparent in internet society, such as the digital divide/e-Gap, security, and network-based crimes. Modern ICT should confront these
difficult problems and provide solutions by bringing sociality and humanity into computing models. In fact, based on Cognitive Informatics (Wang, 2002), a model of cognitive properties to bring human factors and social relations into information processing was proposed and discussed by Wang and Kinsner (Wang, 2005; Wang, 2006; Wang, 2007).

To overcome these problems, *Symbiotic computing*, which we have proposed, provides a conceptual scheme to bridge an e-Gap between RS and DS (Shiratori, 2005; Suganuma, 2006). We considered that the e-Gap, from which problems arise, results from a lack of mutual cognition between RS and DS: people cannot receive advanced services without IT skills. Consequently, DS cannot provide a service suitable for users depending on their respective situations and preferences. Moreover, DS cannot provide a safe and secure service without heuristics related to a person’s activities in a society, such as customs, norms, and expertise.

In our scheme, the agent-based design models of both the symbiotic function (SF) and the symbiotic application system (SAS), which consists of many SFs that support various activities of people, are adopted based on agent-based computing technologies. An SAS operates in an open distributed environment in which RS and DS fluctuate from time to time and provide stable services for people. Therefore, the SAS must deal with such fluctuations autonomously by tuning and changing its structure and functions. The necessary properties of an SAS such as intelligent, flexible, and adaptive properties can be realized easily by composing the SAS as an “Agent System” (Sugawara, 2007). In this paper, we specifically examine agent and multiagent technologies for building an SAS over an open distributed environment.

Generally, software with new characteristics such as autonomy and sociality is called an agent; an information system that uses agents as its components is called an agent system. Agent systems of many kinds have been designed and developed using recent agent technologies. As described above, in our symbiotic computing project, various SF are designed and implemented as software agents; an SAS is also realized as an agent system by selecting and organizing these agents dynamically.

However, the design and debugging of agent systems persists as a difficult problem not only because of the situational and nondeterministic behavioral properties of the agents, but also because of the lack of an effective design method and design-support technologies. To date, we have studied an agent-repository-based multiagent framework called ADIPS, which accumulates the developed agents and agent systems in an agent repository and which enables the dynamic composition and re-composition of agent systems based on this repository (Kinoshita, 1998; Fujita, 1998). Applying the ADIPS/DASH framework, a recent implementation of ADIPS framework with an effective agent repository (Hara, 2002; Uchiya, 2002; Uchiya, 2003), we developed various agent systems in our previous work (Suganuma, 2003; Imai, 2004; Konno, 2004; Kitagata, 2005; Takahashi, 2006; Abar, 2008; Takahashi, 2009; Kim, 2010).

In this paper, we propose a design support facility of agent systems based on the repository-based multiagent framework, thereby providing an efficient and systematic design environment for SAS designers. In section two, we discuss the state of the art of technologies and essential problems of agent system design. In section three, we present an overview of ADIPS/DASH framework as a basis for developing agent systems, and in section four, we propose an interactive design method of agent systems based on ADIPS/DASH framework. In this method, designers can interact with the repository in a design process of target agent system and use/reuse contents of the repository. The method emphasizes the essential features of agent system design based on the repository: (i) systematic use and reuse of existing agents and agent systems accumulated in the repository, and