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Expert Systems with Applications 31 (2006) 673–683
Expert Systems with Applications
www.elsevier.com/locate/eswa

An intelligent speech interface for personal assistants in R&D projects

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Abstract

Groupware and collaborative tools have been proposed to support cooperative work. However, they suffer from some rather severe limitations. Alternatively, multi-agent systems can be proposed to improve the situation. In the latter case, the user normally interacts with the system through a special agent called a personal assistant. In this paper, we describe the design of an ontology-based speech interface for personal assistants applied in the context of cooperative projects. We believe that this type of interface will improve the quality of assistance and increase collaboration between project members. We present the interface and its insertion into a multi-agent system designed for research and development projects. We describe the design of the interface, highlighting the role of ontologies for semantic interpretation. As a result of this conversational speech interface, we expect an increase in the quality of assistance and a reduction in the time needed to answer user's requests.

Keywords: Speech interface; Ontology; Personal assistants; R&D Projects

1. Introduction

During the past few years, different projects have been developed involving multi-agent systems (MAS) for improving computer-supported cooperative work Shen and Wang (2003), Spinosa, Quandt, and Ramos (2002), Tacla and Barthès (2002) or Wu et al. (2002). The application of such an approach can potentially improve the exchange of information among the participants, provide support, improve workflows and procedure controls, and provide convenient user interfaces to CSCW systems. They are an alternative to groupware or collaborative tools that suffer from some limitations as reported by Enembreck and Barthès (2002). Tacla mentioned (Tacla, 2001) that groupware and collaborative tools offer a solution by bundling applications needed by the user. As a result, users can rely on shared spaces to organize their documents and can automate some simple tasks. However, as shown in Enembreck and Barthès (2002), four main problems arise when using them:

- domain-specific tasks cannot be represented easily, i.e., tasks like "design an electrical engine" cannot be expressed with a sufficient level of details without extensive customization;
- tools (e-mail, search engine, agenda) are usually not tightly integrated;
- users' preferences are usually ignored outside cosmetic interface customization;
- users' experiences are not recorded and thus are lost.

To overcome such limitations, we propose to use personal assistants (PA) and multi-agent systems (MAS). The

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doi:10.1016/j.eswa.2006.01.018

particular skills of a PA are devoted to understanding its master and presenting the information intelligently and in a timely manner. The main goal of such an agent is to reduce the user's cognitive load. In principle, the approach does not suffer from the aforementioned limitations, since a PA can be developed so as to adapt to his/her owner, providing the necessary semantic glue to access external services in a uniform fashion. In this approach, information can be captured on the fly, improving knowledge management (KM).

As we will show in details, this strategy enables a personalized solution, since the PA can integrate a group of specialized agents working exclusively for the user. It has a pro-active behavior, anticipating user's needs, and saving user's time. Agents allow the distribution and reuse of knowledge sources. Hence, partial information from different sources can be used to solve a given problem. We consider that each user is a source of knowledge that the PA tries to represent and make available to other users. Finally, PAs offer a very good opportunity to test new interface paradigms like the one we present in the paper.

As in any software application, an appropriate user interface—if possible user-friendly—is essential. Traditionally, developers use graphic-oriented interfaces (containing menus, sub-menus and dialogue-boxes). Often this approach is inappropriate or not very appealing, leading to an interaction of poor quality. In the case of a PA, it may decrease the quality of assistance the agent can offer. On the other hand, conversational interfaces as defined by Kölzer (1999) let users state what they want in their own terms, just as they would do if they were speaking to another person. Of course, the control of interaction is more complex, but this complexity is handled by the system. Conversational interfaces let users concentrate on their main activity and, once in a while, exchange spoken words with their PA.

We are applying this approach to multi-agent system (MAS) managing knowledge in the context of research and development (R&D) projects, as detailed by Tacla and Barthès (2002). Agents belong to a networked environment, providing a natural communication channel to the users and a flexible and dynamic approach to distributed/multidisciplinary design teams, which can reduce redundant design activities, and improve coordination, as indicated by Chao, Norman, Anane, and James (2002). Communication is the support of a good collaborative environment. Here we use PAs to provide synchronous and asynchronous communications among the members of the project. Team members can use their PA to send e-mails, have online discussions, share documents, see others' activities, delegate activities, etc. Each user may speak with the PA in English in order to control it or to ask it to perform some task. The user and his/her PA use a practical dialogue—which means that they are pursuing specific goals or solving tasks cooperatively—as defined by Allen, Ferguson, and Stent (2001). The dialogue system is task-oriented. Tasks range from simple tasks like "locate the report on agent simulation" to more complex tasks that must be decomposed into subtasks.

From the interaction point of view, we expect:

- to improve the quality of assistance; and
- to reduce the user's cognitive load.

From the R&D project point of view, we expect:

- to better trace users operations, by collecting and by interpreting their needs expressed in spoken natural language inputs;
- to capture and to capitalize knowledge on the fly, since inputs are interpreted and formally represented; and
- to increase the PA and the system utilization, contributing to faster project development.

In this paper, we discuss how a PA with an ontology-based speech interface can improve the collaborative work and knowledge management in research and development projects. The paper begins by describing the MAS architecture, the PA and the impact of speech technology in the design of our approach. After that, we present the ontology-based speech architecture. We then describe how ontologies are used for syntactic and semantic interpretation and for task representation. Finally, we indicate some perspectives.

2. The MAS architecture

This section describes our MAS architecture for KM systems in research and development projects, following Tacla and Barthès (2002). R&D teams have no time to organize project information, nor to articulate the rationale behind the actions that generate the information. Thus, our main goal is to design a system that supports collaborative work and helps team members capture and organize knowledge without overloading them with extra-work.

Some of the general requirements for a KM system that guided the project were:

- the system must cover as much of the R&D activity as possible;
- it must save time by helping the user in the day-to-day activities;
- it must support users in creating and sharing knowledge;
- it must be reliable, secure and persistent.

The first reason to employ MAS in KM systems is that, like in a team, an MAS consists of a group of possibly heterogeneous and autonomous agents that share a common goal and work cooperatively to achieve it.

Our MAS contains two types of agents: *Service Agents* providing a particular type of service corresponding to specific skills, and, *PAs* in charge of interfacing humans to the system. The particular skills of PAs are devoted to understanding their master (i.e., the user which is its owner) and to presenting the information intelligently and in a timely manner.