Design of An Agent-based Middleware for Job Matchmaking in Teleworking Community

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ABSTRACT
In this paper, we proposed an agent-based middleware for Job Matchmaking in a teleworking community. We built an agent-based model of organizing distributed teleworkers for big projects and designed a multi-agent system that performs job matchmaking. The matchmaking agent can also carry out negotiation tasks to make a better match. The matchmaking agents use teleworkers' heuristics acquired dynamically through user interface agents to search for suitable working relationships among many participants in a teleworking community, who are also represented by agents.

Categories and Subject Descriptors
Middle-agents, Agent-mediated electronic commerce

General Terms
Design.

Keywords
Matchmaker, agent-based middleware, heuristic-based ranking.

1 INTRODUCTION
Intelligent agent technology is increasingly expected to serve as effective solutions to problems caused by immature IT. Agent-based applications, such as matchmaking and web-search applications, are continuously developing and maturing through the course of research and experiments. Research in using intelligent agents to aid the matchmaking process among service providers and service requesters has been carried on by many groups. For example, the Intelligent Software Agent Group at CMU has developed several matchmaking systems for an agent to find another who has the desired ability to carry out a task [1]. Also, researchers in the Market-Based Method Group at the University of Pennsylvania are trying to use market-based methods such as auctions to help the service requester find the best service provider.

We define telework as the following 2 categories:

1. A working form of a virtual enterprise composed either of geographically separated departments within the same company or of departments of different companies.

2. A working form of a temporary and dynamic organization formed by small companies and home offices to gain and fulfill projects.

One problem related to the second category, which is also the focus of our research, is how to match the most appropriate teleworkers to the most appropriate positions of a project, thus dynamically organizing a project team (Optimal Project Teaming). The goal of our research is to provide such functions by an agent-based middleware, which can match make among teleworkers competing for contracts in the project teaming process of a teleworking community. We propose a matchmaking algorithm and, to ensure more accurate matchmaking, we also design a negotiation protocol for matchmaking agents.

2. Job Matchmaking
There are many web portals that provide information and simple utilities to help teleworkers find jobs and/or workers. Information provided on web portals is public information. Information not available on web portals which needs to be made clear through contacts and negotiations by teleworkers is non-public information. A common scenario of contract making based on the current information and existing technology provided by web portals might be (as shown in Fig. 1): A teleworker searches the portal and makes a list of contract candidates. He then uses email, telephone, or other means to contact each candidate on the list to obtain non-public information. According to the public and non-public information he obtains, he makes his decisions. In this process, we see the following two kinds of burdens for teleworkers,

There is a great deal of information to check before deciding on a list of appropriate contract candidates.

It is very time-consuming for a teleworker to obtain non-public information.

### 3. Overview of the System

The Structure of the system designed to reduce the above burdens is shown in Fig. 2. It includes,

1. **JSA**: Job Search Agent which searches a job for a worker who sends out a Worker Information to employers. This agent can carry out negotiation tasks to find an optimal job automatically.

2. **WSA**: Worker Search Agent which searches workers for an employer who sends out a Job Information to workers. This agent can also carry out negotiation tasks to find suitable workers for the job automatically.

3. **EA**: Employer Assistant Agent which can acquire Job Information from an employer. It acts for the teleworker as an intelligent interface.

4. **WA**: Worker Assistant Agent which can acquire Worker Information from a worker (a job contractor). It also acts as an interface.

5. **WIB**: Worker Information Blackboard which contains information submitted by WAs.

6. **JIB**: Job Information Blackboard which contains information submitted by EAs.

The system is designed in a secure way so that non-public information of a certain teleworker can only be viewed by the teleworker himself or by related agents. The agents in the system are designed in a secure way so that they do not report non-public information to any human user unless the information belongs to that user.

A Job Request or a Worker Request from a teleworker or the information carried by a WA or an EA includes four parts: 1) public information, 2) non-public information, 3) criterion for candidates, and 4) negotiation rules.

Information 1 and 2 will be written onto either the JIB or the WIB by WA or EA. Information 3 and 4 will be given to a JSA or a WSA. A JSA will use information 3 and a personalized ranking function to rank all the Worker Requests on the WIB, including Worker Requests from EAs. Then, the JSA asks the rank of itself in the lists of several WSAs, which are among either the top 10 or the top x entries in the JSA’s list. According to the results, negotiation will be carried out. For some very complicated cases, the matchmaking agent may need to ask the human user for a decision. After the negotiation, the JSA can provide a list of suitable candidates who are ranked as the best possible business opportunities for the teleworker. This list and the reason for choosing each candidate will be returned to the WA for a human user’s consideration.

### 4. Experimental System

We use DASH (distributed Agent System based on Hybrid architecture) to develop the system [2]. DASH is a system of distributed agent virtual machines built by Java, and it can be used to program a multi-agent system running on the Internet. It also provides a language to program knowledge of agents based on a production model, which is suitable to use for programming the negotiation knowledge and coordination between agents.

### 5. Conclusions

In this paper, we design a middleware to support job matchmaking in a teleworking community and describe our development of an experimental system to evaluate our solutions. Our system has agents carry not only public information, but also non-public information to perform matchmaking automatically. The work for human users is reduced.

### 6. Reference
