

ALAWAI : Agent Languages and AgentWare for Agent Invention

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ALAWAI is an integrated environment for rapid development of intelligent agents which collaboratively operate on a distributed environment. It provides agent system components such as multimedia user interface parts, inter-agent communication languages, plans, user models, and agent system framework to which those components can be visually glued together. For a greater productivity, stereotypical agents are already defined for various task domains which can be easily adapted to meet more specific needs with help of user support agencies of ALAWAI. This paper describes some of the key features of ALAWAI and an example creation of intelligent agent which assists Internet exploration.

1. Background

Current trend in intelligent system is characterized by multiple communication modality, distribution of information and control, and flexible adaptation to the user. Distributed multimedia and global information network such as Internet are the key enabling technologies for such a system. Unfortunately, the development of intelligent systems continues to suffer from the following two problems; low productivity and high cost for the implementation; lack of unifying scheme for these technologies.

Intelligent agent technology is a new approach to the intelligent system development which harmoniously works with distributed multimedia and Internet technologies. It also allows the developer to create intelligent system with greater adaptability to the user. The most successful examples of Intelligent agent understand user's language, infer user's real goals, derive plans to satisfy user's goals, and carry out the plans. Such agents also utilize various multimedia resources and other agents on the network, in order to communicate to the user in the most effective way.

2. ALAWAI System Overview

Figure 1 shows the agent invention process. In ALAWAI, invention of an agent means selection of a stereotype agent from AgentWare repository, adaptation to a particular problem, and testing by simulation. These tasks are supported by ALAWAI's user support agents. Agentware and resource necessary for simulation are available on the network.

Stereotypes of agent exist for different task domains. A stereotype agent has a typical knowledge already embedded in its framework. Adaptation to a specific task will be done either by knowledge adjustment or by training. The adjustment process involves deletion, alternation, and addition of knowledge. For example, a shopping agent may need to change security clearing process depending on the regulation of country. To facilitate this process, the knowledge is organized using structural relations such as decomposition and alternative. Training is achieved using agent's inherent ability to question and learn from user. For example, agent can learn behavior of the user by observing user's daily computer interaction patterns and verify with the user if the agent guessed it right.

Figure 2 shows a framework of agent. Triggered by an event, agent either instantly react and take action (*reactive agent*), or first interprets the meaning of the event and requires

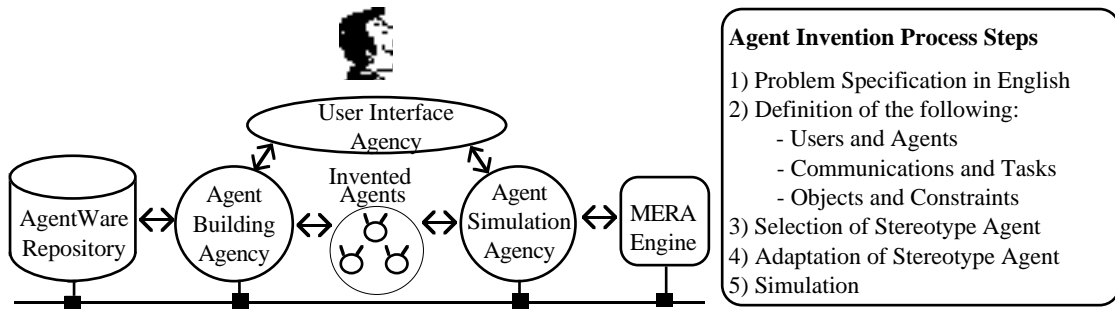


Figure 1: ALAWAI overview

extensive knowledge interaction at each process step defined in the framework. The knowledge can be typed by its dynamism, domain dependency, or level of definition. For example, dynamic knowledge is sensitive to time, location, culture, and other variables, and therefore requires maintenance. Applicability of domain dependent knowledge is limited to particular domain, whereas domain-independent knowledge is more universally applicable. Special kind of knowledge, called meta knowledge, includes inference rules, language syntax, and other things needed to use the knowledge.

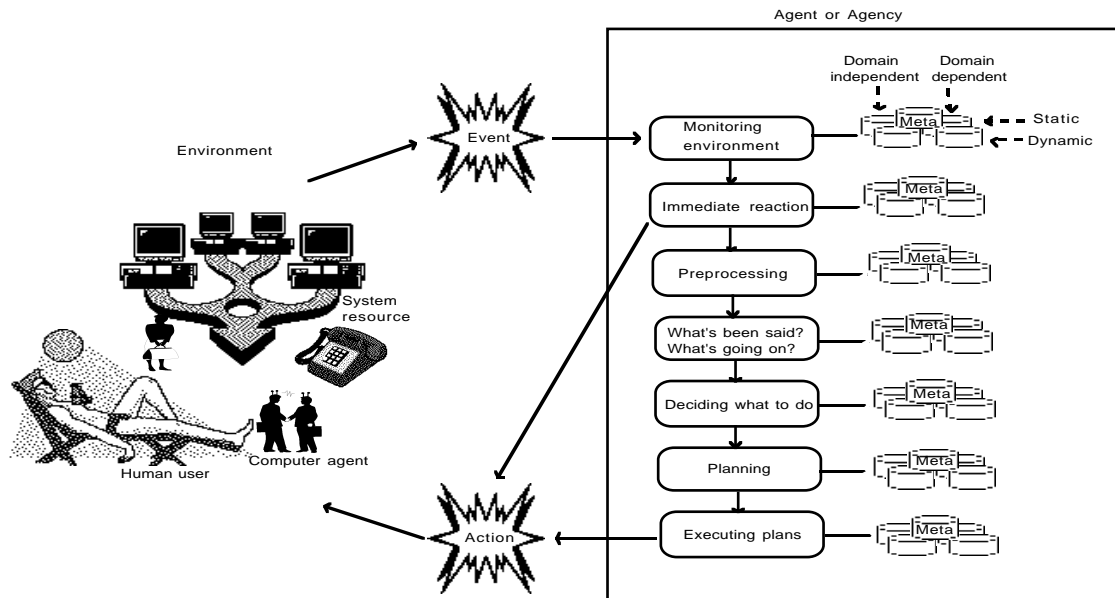


Figure 2: Agent framework

The knowledge contents, inter-agent communication contents, as well as various object definitions are written in a visual diagramming language called MERA[1]. MERA is a generalization of well-known ER (Entity-Relationship) model. Developed at University of Hawaii in 1984, MERA has been favored by many software engineers for its ability to model both declarative and procedural aspects of software. MERA is also used to describe software engineering activities at both individual and group levels. Two MERA diagrams in figure 3 are examples of KQML[2] based agent communication language syntax (*formalism diagram*) and a plan to open URL (*instance diagram*). Universal use of MERA in ALAWAI system facilitates interaction among agent components and knowledge.

Agents employ high level communication to solve problems. ALAWAI provides language syntaxes for the following essential tasks: 1) World object naming and visualization, 2) User-agent communication, 3) Information contents description, 4) Goal and plan description, 5) System resource description, 6) Inter-agent communication, 7) Information retrieval, and 8) User Modeling.

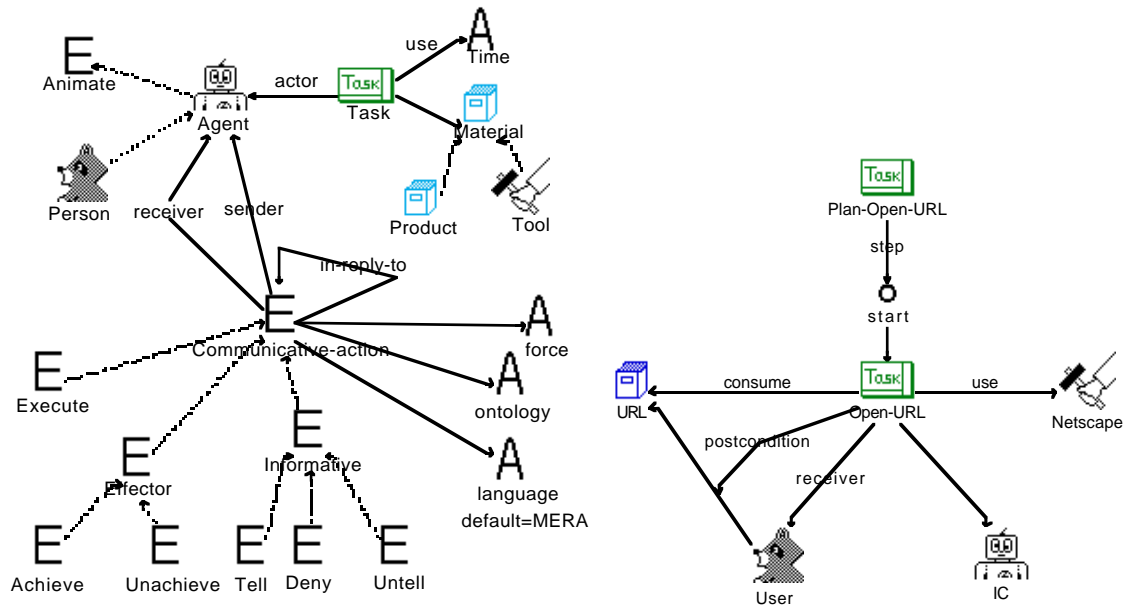


Figure 3: MERA representation of KQML syntax and a plan

World object naming and visualization language allows specification of object name and properties, and inter-object relations including spatial relations. The specification will become a common object reference model for the agent and the user. The model provides common domain vocabulary for them to communicate about the tasks, and also provides the base for the graphical user interface. *User-agent communication language* is an alternative to ambiguous natural language and simplistic dialogs in GUI. It supports communication of plans, goal and constraints. *Information contents description language* is based on semantic network and defines communication contents. *Goal and plan description language* allows modular definition and parametrized definition for greater reusability of the knowledge. *System resource description language* is used to define tool functionalities, operating system, database types, and other resources available to the agent over the network. *Inter-agent communication language* is based on Speech Acts [3] theory as is KQML. *Information retrieval language* allows specification of search request without requiring the user to know about the search domain and search process. *User Modeling language* is particularly important as adaptability to each user is one of the essential feature of agent. This language not only describes user preferences, user types, but also cultural background of the user.

All of these languages are specializations of MERA, and are interpreted by the MERA engine.

3. Example agent

One of agent systems we have developed with ALAWAI's components and methodology is Internet Consultant (IC)[4]. It is an intelligent agent that assists information searching activities on the Internet. It accepts natural language input as a query from the keyboard or from microphone. IC also provides the user adaptive multimedia interface to tailor the result of the query. Internally it is implemented as a multi-agent system based on the cognitive agent framework of ALAWAI. Natural language interface agent understands user's utterance and extracts his/her goals. Planning agent generates and executes plans to achieve the goals. Information agent chooses the most appropriate search engine for the user's intention, makes a query, and tailor the results of the query. IC was developed in a short period of time and proved the effectiveness of ALAWAI system.

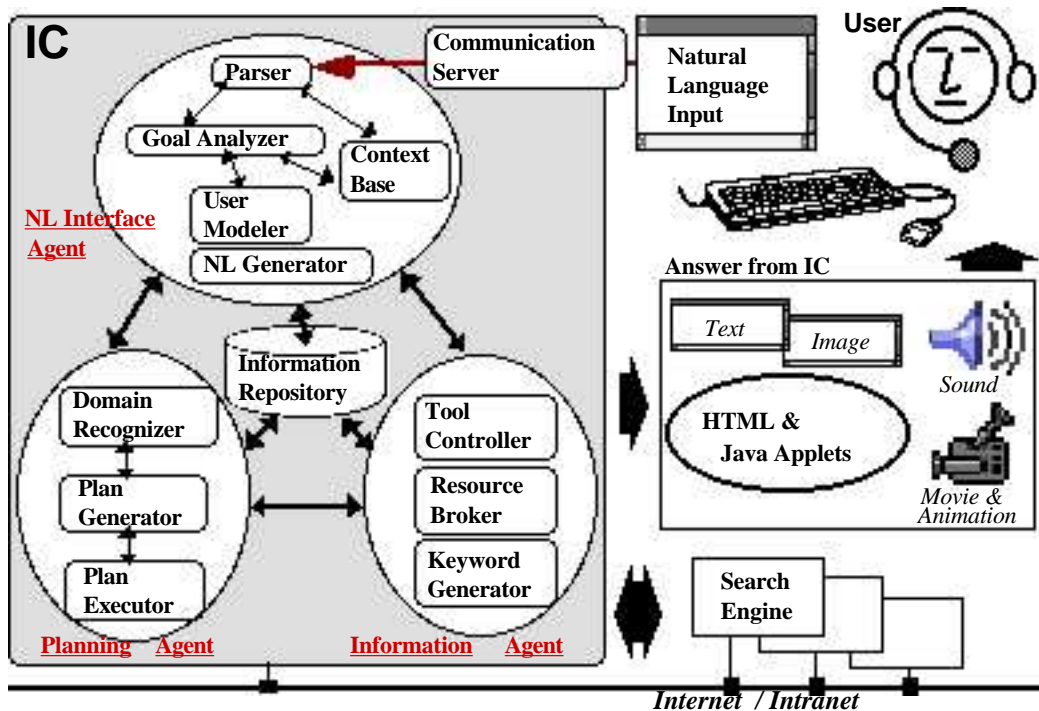


Figure 4: Example of agent (IC: Internet Consultant)

4. Remark

We expect agent technology to be the key to drastic productivity improvement for intelligent system development. Since 1990, we have been committed to creation of complete tool set to support various phases of agent engineering process. ALAWAI is an answer to the knowledge acquisition bottleneck for knowledge intensive agent system development. Another tool being developed is MAUI[5], Multimedia Agent-User Interface prototyping tool, which supports simulation of multimedia user-agent interface behavior, and visualization of multiple-agent interaction. Yet another tool under development is MAWAE[6], Mapping of World Activity Environment, which models various world activities and organizes. It will connect up various domain specific knowledge defined in ALAWAI and which exist in disconnected way. Finally, based on our vast experiences in software development and agent development, we are working on development of a formal agent development and maintenance methodologies and process supporting tools. For more reports on our latest agent research projects, please visit our web site[7].

References

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