

Active Information Resource: Design Concept and Example

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Abstract

To reduce the burden for users that utilize information from distributed information resources, the deployment of distributed Active Information Resource (AIR) is proposed. An AIR is a information resource that is enhanced with the knowledge of the content and the functionality for actively and flexibly supporting use/reuse of the content. Multiple AIRs could cooperate actively and automatically to target the proper information resources, carry out complex information processing and then provide composite result. In this paper, the concept and main use of AIR are discussed. Also, the construction and information processing of AIR, as well as an experimental implementation of agent-based AIR system, are introduced.

1. Introduction

Along with the “Information Explosion” and the rapid growth in network use, distributed electronic information resources are continuously being generated, accumulated and updated. Contemporarily, it remains to be studied how to help the user more efficiently use/reuse the information resources [1, 2].

To utilize information from various distributed information resources, the user will likely spend plenty of time to do searching, data processing and to get skilled, and spend plenty of computer and network resources at the same time, although there are considerably numerous web portals, search engines, directory services and other web services that can help the user target information resources. In some cases, the user might not get the exact result that he wants due to not being able to target proper information resources and/or to manipulate the information correctly.

As a method for solving the problem mentioned above, Active Information Resource (AIR) is discussed in this paper. In section 2, the concept, form and main use of AIR will be described. And then, the construction of AIR and the

AIR Repository will be discussed in section 3 and section 4, respectively. In section 5, an experimental implementation of agent-based AIR system is to be introduced.

2. Active Information Resource

2.1. Concept of AIR

In the current model of accessing and utilizing distributed information resource, although the user can access the sea of information with the aid of web browsers, search engines and other web services, it remains as a problem how to use the distributed information effectively according to the request of user (or application), since there are gaps among the maintenance of information, processing of information according to the request of user, and facilitating the use/reuse of information.

Trying to provide a method for solving the problem mentioned above, we consider enhancing and extending the distributed information resource to allow it deal with requests for information more actively and flexibly. Not only the content of information itself, but also the knowledge of the content, as well as the knowledge and functionality for actively and flexibly supporting use/reuse of the content, should be maintained to construct an information resource. Such an information resource is called an Active Information Resource, or AIR[3].

Based on its content and knowledge, an AIR is able to respond to requests for information actively and flexibly by launching proper utilization supporting functions. Furthermore, distributed AIRs should be able to cooperate actively and autonomously to share their knowledge, functionalities and contents of information, to target the proper information resources, to carry out complex information processing and then provide composite results (see figure 1).

With aid of distributed AIRs, it can be expected that information retrieving and processing could be more effective than those performed by users. Thus the burden for users could be reduced.

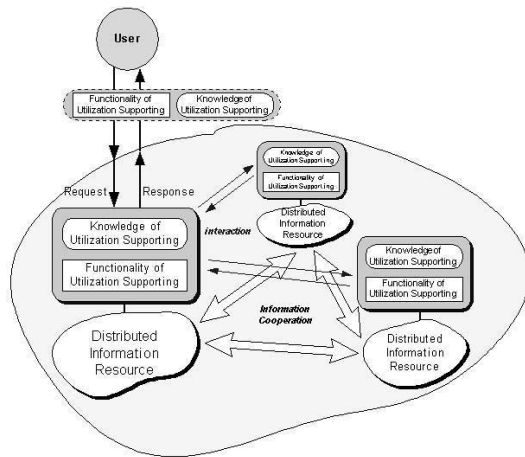


Figure 1. Information cooperation among distributed AIRs

2.2. Forms of AIR

Depending on the way the information resource and the part of knowledge and functionality are combined, there could be mainly three forms of AIRs, as shown in figure 2. Other kinds of AIRs could be formed by combining them.

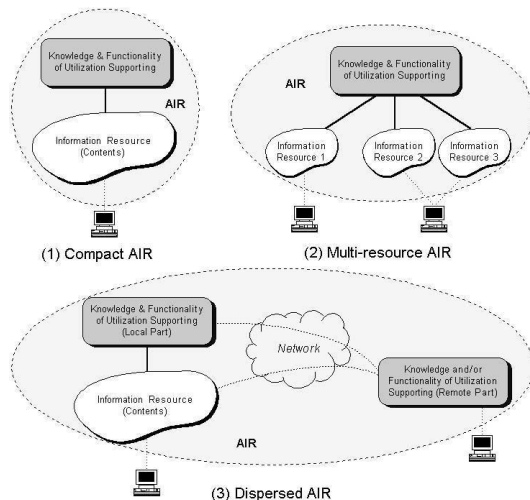


Figure 2. Main forms of AIR

2.3. Cooperation of AIR

The basic cooperation among AIRs should be as follows:

- The request for information is sent to several AIRs, and each of them deals with the request independently. Finally, an AIR integrates all the results.
- An AIR breaks down the request into several parts, and distributes each of them to an AIR, which then deals with the request independently. At last, the results provided by all of the AIRs are integrated by the first AIR.
- The request is processed by one AIR after another with the information being transferred, until the last AIR provides the result expected by user.

2.4. Use of AIR

Based on its knowledge about information contents, knowledge about information processing, and functionality of information processing, an AIR is expected to retrieve desired information more precisely, and process the information more properly. Besides, through cooperation among AIRs, more information could be obtained effectively. Moreover, composite result that satisfies the user better could be provided, when the AIRs share their functionalities to process the retrieved information. Thus, by deploying AIR, the use and reuse of distributed information resource are expected to be more effective and flexible.

Following are some examples of typical use of AIR.

- *Effective information retrieving/processing/integrating*
- *Facilitating use and reuse of digital information products, information service, software, etc.*
- *Construction of self-organizing knowledge base*

3. Construction of AIR

3.1. Knowledge of AIR

The knowledge of AIR for supporting utilization should be represented in a frame-based way. Corresponding to each type of knowledge, there should be a frame consisting of a group of slots. Generally, the knowledge consists of following types:

- *Knowledge about information content* that it holds
- *Knowledge about processing on information content*
- *Knowledge of cooperation with other AIRs*

3.2. Functionality of AIR

Via proper functionality an AIR has, information utilization supporting could be carried out. The typical functionality of AIR should include these parts:

- *Functionality to analyze the request it receives*
- *Functionality to perform processing on information*
- *Functionality to maintain its knowledge*
- *Functionality to cooperate with other AIRs*

3.3. AIR Based on Software Agent

Observing the expected behaviors of the AIR, some features could be found quite similar with the software agent. These features include: responding to outside requests and perform actions automatically on basis of knowledge, cooperating with each other autonomously, etc. [5]. Thus it should be rational to consider implementing AIR by using software agent technology.

While constructing an AIR, the enhancement and extension to existing information resource could be implemented as an agent, which is called AIR agent, or AIRA. The knowledge of AIR could be mapped into the knowledge of AIRA, and the functionality of AIR could be mapped into the functionality of AIRA.

4. AIR Repository

In Agent-based AIR systems, it is necessary to manage AIRAs, to make them find each other easily, and organize together for cooperation. Thus, the deployment of AIR Repository is considered (figure 3). Moreover, through co-operation among distributed AIR Repositories, AIRs will be managed and utilized more effectively. Generally, the main functions that an AIR Repository should provide include:

- *Directory Service*
- *Request Redirection*
- *AIR Community Organization*
- *Experience Reuse*

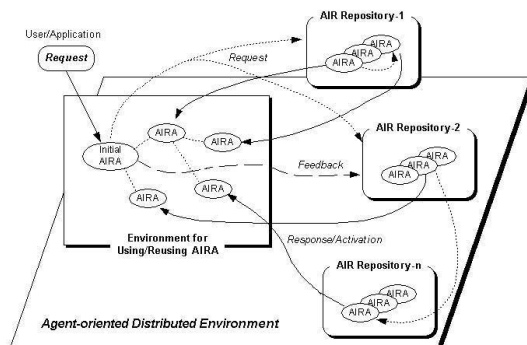


Figure 3. Deployment of AIR Repositories

5. An Experimental AIR System

We have developed an experimental Agent-based AIR system on ADIPS agent framework [6, 7]. This experimental system is used to demonstrate and verify some basic features of AIR, including retrieving information, targeting related AIRs, generating and forwarding request, integrating result, as well as some basic functions of AIR Repository, including *Directory Service* and *Request Redirection*.

5.1. Constitution of the Experimental System

In this system, three types of information are available to user: *Biographies of Famous People*, *Works of Literature*, and *News about Art*. In response to user's request, this system is expected to retrieve information that matches the request as much as possible, and provide composite result the user. All these should be achieved via active cooperation among AIRs. As shown in figure 4, this system includes following parts:

- **AIR Repository**, which carries out registration and discovery of AIRs, as well as request redirection. In this system, it is implemented as an agent.
- **Initial AIR**, which gets user's input, raises requests according to the input, and feeds back the result of information processing to the user.
- **Biog AIR**, **WOL AIR** and **NAA AIR**, corresponding to the information resources of *Biographies of Famous People*, *Works of Literature* and *News about Art*.

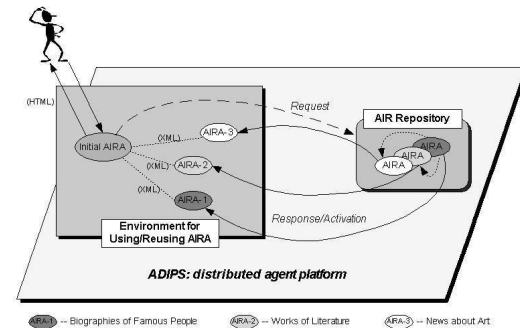


Figure 4. An experimental AIR system

There are also two agents, the **HTML Generator Agent** and the **HTML Viewer Agent**, not shown in the figure. They are used to format the result of information processing into HTML files, and display them, respectively.

Each AIR is implemented based on an agent (AIRA). For each AIRA, there is a set of metadata stored in a file which is expressed in XML/RDF [8]. Both knowledge about the information contents of the AIR and knowledge about other AIRs related to some of the contents are maintained.

This system was implemented and tested on a platform of Windows XP Professional / AMD Athlon XP2000+ / 512MB, using ADIPS/DASH Version 1.1d and Java 2 SDK, Standard Edition Version 1.4.0.

5.2. Behaviors of the Experimental System

In this system, the behaviors of involved parts are carried out as follows:

- (1) **Request Raising.** According to the input of user, the *Initial AIR* generates a request in standard format, and sends it to the AIR Repository.
- (2) **Request Redirecting.** The AIR Repository receives the request, analyzes it on basis of its knowledge about all AIRs, and then forwards it to those considered to be able to provide proper information.
- (3) **Request Processing.** When an AIR receives a request, it will analyze the request, extract and summarize proper information that matches the request basing on its knowledge. If it considers that some other AIRs might contain useful information corresponding to the request, it will also forward the request to them.
- (4) **Information Integrating.** When all the engaged AIRs have reported to Initial AIR, or a certain time limit is reached, the Initial AIR will try to integrate all of the results and show the final result.

5.3. An Example Scenario

The user is going to find information about Yasunari Kawabata, a Japanese writer who was awarded the Nobel Prize in Literature in 1968. In fact, in *Biog AIR*, there is a piece of biography of this writer. In *WOL AIR*, there are also

some documents introducing his famous works. In *NAA AIR*, a few pieces of news, in which Yasunari Kawabata was mentioned, are stored. This system is respected to retrieve all of these information, and provide a composite result.

Firstly, in the phase of **Request Raising**, the user inputs “Yasunari Kawabata” as the keyword, and input “Name of Person” to describe that keyword. Then the *Initial AIR* generates and sends the request to *AIR Repository*.

In the **Request Redirecting** phase, the AIR Repository, according to its knowledge, forwards the request to Biographies of Famous People AIR, then report that to Initial AIR.

In the **Request Processing** phase, the *Biog AIR* receives the request, and extracts a piece of biography of “Yasunari Kawabata” in response to the request. It also finds that there might be some useful information in *WOL AIR* and *NAA AIR*, so it forwards the request to those two AIRs. When *WOL AIR* receives the request, it extracts proper information, and forwards the request to *Biog AIR*. Since this request has already been processed by the latter, it is ignored for this time. Similar thing happens to *NAA AIR*. All of the results and lists of AIRs that the request is forwarded to are reported to *Initial AIR*, respectively.

When *Initial AIR* receives reports from all of the three engaged AIRs, the process enters **Information Integrating** phase. With the aid of *HTML Generator Agent* and *HTML Viewer Agent*, *Initial AIR* integrates the results and presents it to the user as an HTML page, as shown in figure 5 (the background of this figure is the GUI of ADIPS).

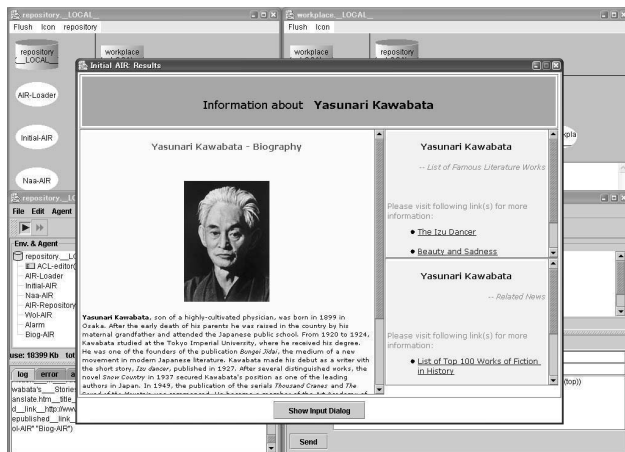


Figure 5. Result of information processing

5.4. Evaluation

This experimental system shows that, by deploying agent-based AIRs, the user could be able to obtain desired information via simple operation. Moreover, the obtained information could be composite, which means that although the parts of it are stored in different information resources, the user does not need to by himself access them one by one. The AIRs in this system prove to be able to retrieve and process information actively via cooperation.

In brief, this system shows these features, while the first two distinguish AIRs from conventional information resources: *easy to use*, *speedy and correct*, and *scalable*.

6. Conclusion

This paper has discussed the concept and main use of Active Information Resource (AIR), as well as the construction and information processing of AIR. In this paper, an experimental implementation of agent-based AIR system has also been presented. According to the results of experiments, an AIR system could be implemented based on software agents, and multiple AIRs are able to organize autonomously and to provide composite information actively via cooperation.

However, there are some aspects of AIR remain to be studied further, including:

- Common protocols for AIR cooperation
- Maintenance of AIR's knowledge
- Functionality and knowledge of AIR Repository, etc.

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