Mobile Agent for Distributed Information Retrieval System

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***Abstract*- A mobile agent is an executing program that can migrate during execution from machine to machine in a heterogeneous network. On each machine, the agent interacts with stationary service agents and other resources to accomplish its task. Consequently, mobile agents are particularly attractive in distributed information retrieval applications. On behalf of a user, by migrating to the location of an information resource, the agent can search the resource locally, eliminating the transfer of intermediate results across the network and reducing end-to-end latency. By deploying the abilities of mobile agent, this thesis develops a system which can control and manage the distributed information retrieval processing in order to search for the required technical papers from distributed database throughout a network. In this system, the mobile agents can migrate from a host node to various destinations, perform data processing there and send the relevant information back to the host. In order to facilitate such a set of events and actions, many development platforms are available. In this thesis, Java programming language and Java-based mobile agent system, called the Aglets workbench, created by IBM are fully deployed in order to develop the proposed system.**

I. INTRODUCTION

In traditional Client-Server way, most of the information retrieval systems do not offer enough flexibility for distributed data repositories. Generally, there are many specifications in traditional way; setting up a connection between the client and server, sending a request to the database server and receiving the result from the server. If there are N servers in the network, the user has to start N network connections and send out N database queries. The following information is needed to transfer on the network:

- Database query request and
- The result data.

The network connection must be maintained all along. When there are more and more mobile devices, the bandwidth is limited and the devices cannot be online always. At that time, the traditional client-server approach cannot fit [2]. As a popular current solution to solve these problems, a distributed and flexible mobile agent-based architecture is proposed. The Distributed Information Retrieval task deals with the collection of information from multiple and usually heterogeneous information sources that exist in a distributed environment [1]. So Mobile Agent based Distributed Information Retrieval System provides solutions to the problems not to be solved by any of them [6]. Mobile agents follow the steps specified in a predefined process and network traffic, low network latency, disconnect operation, etc. It has the unique ability to transport itself from one system in a network to another. By exploiting the advantages of the agent's mobility, they are especially useful in distributed information retrieval system. The Search Process gets the information about the papers from the remote distributed databases. With this information, the Download Process can carry and save the papers. This system consists of mobile agents that can be configured to control the Search and Download processes.

II. THE PROPOSED SYSTEM ARCHITECTURE

In this section, the proposed system is mainly declared the overall architecture of the system. The advent of large wide-area networks, Internet is the most characteristic example, has caused a vast increase both in the information availability and in the number of the information sources. This evolution offers great promise for obtaining and sharing diverse information conveniently. However, the multitude, diversity and the dynamic nature of on-line information sources make accessing any specific piece of information an extremely difficult task [3]. One way to address these issues is to use information agents. These Distributed Information Retrieval agents should be able to:

- accept a request from a human or agent client,
- translate this request into a language understood by the information sources,
- identify the information sources that contain information relevant to the request,
- pose the requests to these sources,
- collect the corresponding the results
- process the returned results and
- present the results to the client [6].

The system searches and downloads the required technical papers and n agent in each database uses the information and return back result to the user through the Search Agent. When a mobile agent arrives at the remote station, it acts according to the information it is carrying within itself. The agents can easily execute tasks on behalf of the user. The system provides the required technical papers to the user that scale beyond a conventional retrieval system.

This system can be broken into two main parts.

- Mobile Agent-based Distributed Information Retrieval System and
- Mobile Agent-based Downloading System.

There are seven kinds of agents, local / remote data repositories and databases in the overall system.

A Personal Agent is responsible for the creation of Search Agent that can search the required technical papers over the network. After the Search Process, it can create

Download Agent to get the papers from the specified destination.

A Search Mobile Agent can migrate to the desired location carrying the user information for the Search Process. When it arrives at the destination, it negotiates with the Database Agent giving the data for the process. When it gets the results of the process from the Database Agent, it can send them to the Search Agent. After the process, it can dispose itself at the remote station.

A Database Agent is stationary at the remote database. When Search Mobile Agent arrives, it receives the information and searches the required data in the database. When it finds the required data, it retrieves them and transfers to the Search Mobile Agent.

A Search Diary Agent is responsible for receiving search results from Search Agent and inserts the results into local database. After collecting all results, it displays the results required by the user.

A Download Mobile Agent can migrate to the desired location carrying the user information for the Download process. When it arrives at the destination, it reads file data and can send the results to the Download Agent. After the process, it can dispose itself at the remote station.

III. Implementing to The Finite State Machine

In this section, the major components in the proposed system and their corresponding functionalities and responsibilities are described. The proposed system consists of several distributed databases located anywhere in the local LAN [6].

A. Agent Interaction in the Proposed System

The main responsibility of the Search Agent is first to create and coordinate Search Mobile Agents and then initiates some information about the Search Process [4]. The additional responsibilities of a Search Agent are:

- To maintain the information which is given by the user for the process,
- To create and dispatch Search Mobile Agents to remote databases for the process,
- To communicate with Personal Agent to report the information of the whole process.

When Search Mobile Agent does its task, migrating and negotiating, it is necessary to be monitored at runtime in order to enforce the correct execution of the task. After the specified period, Search Mobile Agent receives the result from the Database Agent. And then it has report the result to the Search Agent. After completion of task, Search Mobile Agent sends the result by message passing patterns to Search Agent and then disposes itself at the remote station. When the Search Agent receives the result message, it records the result into local database by the Search Diary Agent and displays the collected results to the user. The main responsibility of the Download Agent is first to create and manage Download Mobile Agent and then initiates some information about the Download Process. The additional responsibilities of a Download Agent are:

- To maintain the information which is got from the Search Process,
- To create and dispatch the Download Mobile Agent to remote for reading file data,
- To communicate with Personal Agent to report the information of the whole process.

A Download Mobile Agent is the agent that can migrate to the remote. When Download Mobile Agent does its task, migrating and reading, it is necessary to be monitored at runtime in order to enforce the correct execution of the task. After the specified period, Download Mobile Agent had read the data from the Data Repository. And then it has to report the result to the Download Agent. After completion of task, Download Mobile Agent sends the result by message passing patterns to Download Agent and then disposes itself. After the Download Agent receives the result message from the Download Mobile Agent, it writes the result and saves in the local data repository at specified location.

Every remote station has a database, which is a repository of information about the technical papers. When a Search Mobile Agent states its requirements, the database is accessed and searched for matches. Structured Query Language (SQL) is a language used to create, manipulate, examine and manage relational databases. SQL was standardized across different database vendors so that a program could communicate with most database systems without having to change commands. Open database connectivity (ODBC) provides a consistent programming language SQL interface for communicating with a database. Using ODBC and SQL, it is possible to connect to a database and manipulate it in a standard way [7].

IV. Interfaces Of The Proposed System

The following Figures are user interfaces of the system. Fig. 1 is the main window which displays all processing of information flows between the Search Agent, Search Mobile Agent, Search Diary Agent, Download Agent, Download Mobile Agent. Thus, if the user wants to get the information of the technical papers, he simply clicks on the appropriate button and a Search Agent frame appears. This section also shows the screenshots from the process model for the searching and downloading scenario. The Search Agent shown in Fig. 2 is used to search the technical papers asking for information about the papers. The user can give the author's name, title or keyword of the paper and the remote database address through this interface. The user then can interact with the agent by adding destination addresses, giving any one or two or three fields of author, title and keywords and then dispatching the Search Mobile Agent by clicking the "Go" button.

When the Search Mobile Agent arrives at the destination, the Search Mobile Agent frame opens up its window at the remote site as shown in Fig. 3 and negotiates with the Database Agent. Search Mobile Agent waits for the searching result while the Database Agent is comparing the required information with the records in the database. After the Search Mobile Agent has got the required data, it sends to the Search Agent. When the Search Agent gets the message, it replies to the Search Mobile Agent about it got the message successfully. Only if the Search Mobile Agent

gets the reply, it is disposed by itself. After disposing, the following frame is closed.

After Search Process, Search Diary Agent displays the results by the Fig. 4 at the user site. Fig. 5 provides the Database Agent interface for each remote database in the system. The proposed system can search and download the papers on behalf of the user, and no one is needed to sit and do anything at the remote site.

According to the search result, the user can download the paper from the remote data repository by the Download Agent. Fig. 6 is the interface window for the Download Agent. The user interacts with the agent by clicking the related button for downloading the paper typing some text for the process. The user can insert the file name, file path and location of the paper which is desired to download. The information: file name, file path and location are got from the searching process. After that, Download Agent creates Download Mobile Agent and dispatches to the desired location by clicking the "Go" button. Upon arrival at the destination, the window as shown in Fig. 7 is popped up and the Download Mobile Agent reads the file data and sends these file data to the Download Agent. After receiving the file data, Download Agent displays the window at the user site as shown in Fig. 8. The user can save the downloaded file by clicking the "Save" button in the window. When the "Save" button is clicked, "Save File" window pop up as shown in Fig. 9. As shown in the figure, the user can save the paper in any data storage area at the local station.

V. Performance Evaluation

The system is divided into two sub-systems: (i) Mobile Agent-based Distributed Information Retrieval System and (ii) Mobile Agent-based Downloading System. The first sub-system is made up of Personal Agent, Search Agent, Search Mobile Agent, Search Diary Agent for user and Database Agent for remote station. The last sub-system is made up of Download Agent and Download Mobile Agent for the user. The agents identified in the design phase are implemented by extending the aglet class. This section describes the experiments of the system as well as the results of the experiments. It draws some conclusions on the applicability of agent technology to distributed information retrieval.

A. Experimental Results of the Proposed System

The performance of the proposed Mobile Agent-based Distributed Information Retrieval System is computed on the basis of the following parameters [5]:

- number of remote database stations in which technical papers are existed and
- execution time for performing each search process.

The performance metric is the execution time or turnaround time, the time elapsed between a user initiating a Search Process to the search agents and receiving the retrieval results from them. This includes the time taken for agent creation, time taken to migrate the results and the processing time to retrieve the required information. Fig. 10 shows the results of Search Process performance by number of stations.

The negotiation turnaround time is defined as the time elapsed that includes the time taken for a Search Mobile Agent dispatching, arriving at the remote site, interacting with the Database Agent, receiving and sending the retrieval information to the Search Agent. So, the performance of the proposed system is also computed on the basis of the following parameters:

- number of remote database stations at which each agent negotiates with the Database Agent
- negotiation time of each agent.

The negotiation time of an agent at the same remote station (A or B or C) is not very different when the number of stations is increased. This makes the proposed system better efficiency and performance as shown in Fig. 11.

In this section, the performance of the Download Process with the collaboration of mobile agents is evaluated. Basically, in downloading system, the performance can be improved by the downloading speed. This speed will be changed by the amount of data size. So, the performance of the proposed system is evaluated by the basis of the following parameters:

- file size measured in kilobyte and
- execution time for servicing the process.

The performance metric is the turnaround time, which is defined as the time elapsed between a user initiating a Download Process to the download agents and receiving the file data from them. This includes the time taken for agent creation, time taken to migrate and the processing time to read the file data. According to experimental results, it is observed that Mobile Agent-based Downloading System presents a better performance of data downloading for a distributed configuration. Fig. 12 shows the results of Download Process performance by the size of a downloaded file increasing the size in double. According to the result, the total time of the whole process is not significantly increased in double even though the file size is increased in double.

VI. Conclusion

In this thesis, the mobile agents can dispatch to a destination host carrying the data for computations at remote site. Mobile agents move the data to the remote distributed databases, not the databases to the data. Therefore, the proposed system has huge bandwidth savings and can overcome network latency. Among the many available software agent packages, Java-based aglet package has a few attractive features. Aglets provide a very powerful, simple API allows for quick implementation and easy deployment. The other major involvement of this thesis is that a practical prototype has been implemented in the system. In the implementation, it has been developed the searching distributed papers and downloading the required paper. This implementation has been achieved and demonstrated with the technical paper download application from the distributed databases. With the support of this approach, retrieval systems can be built in a truly distributed fashion without the help of a central data

repository. Therefore, the failure of a potential single point can not stop the whole system. So, the users are better supported by using this system.

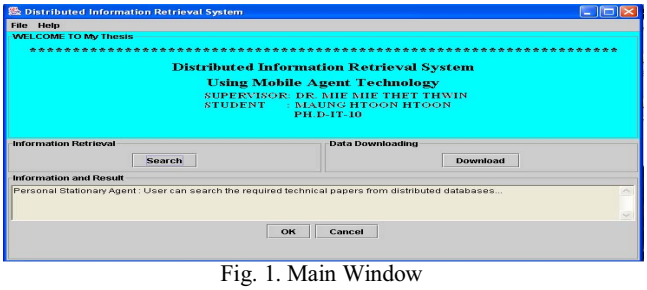

Fig. 1. Main Window

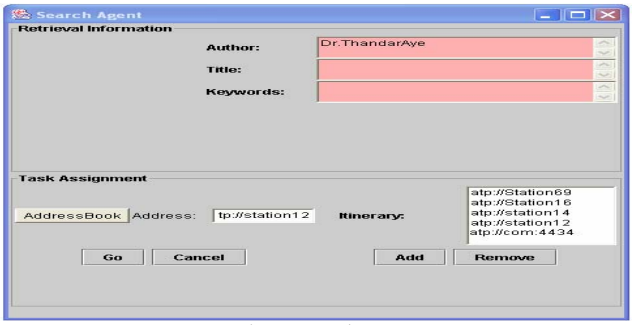

Fig. 2. Search Agent

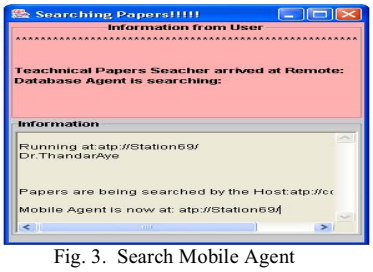

Fig. 3. Search Mobile Agent

Fig. 4. Result Frame Window

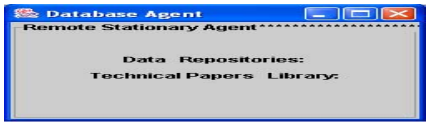

Fig. 5. Database Agent

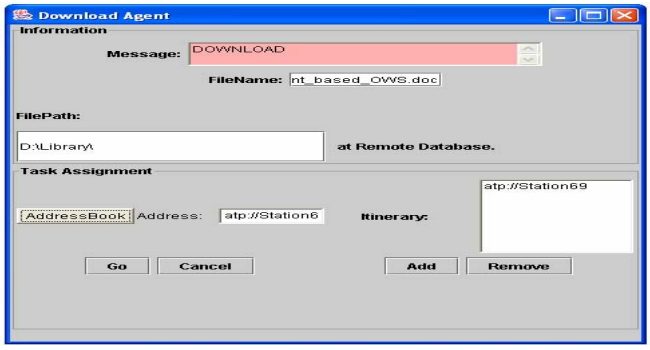

Fig. 6. Download Agent

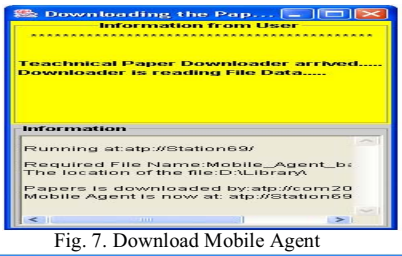

Fig. 7. Download Mobile Agent

Fig. 8. Download Result

Fig. 9. Save File Dialogue

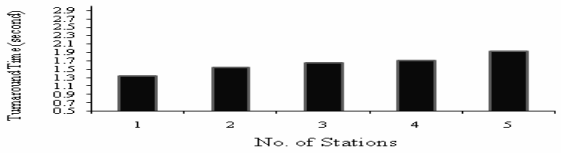

Fig. 10. The Results of Search Process Performance

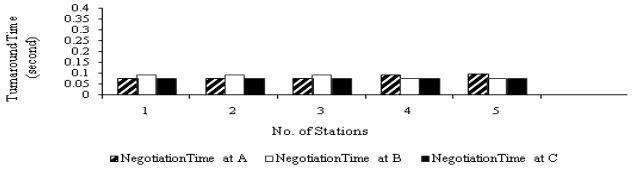

Fig. 11. Comparison of Negotiation Time on No. of Stations

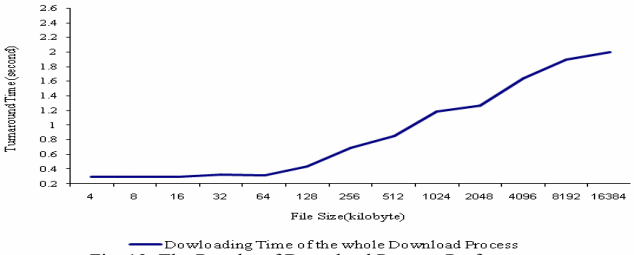

Fig. 12. The Results of Download Process Performance

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