CHAPTER 7

CONCLUSION AND FUTURE ENHANCEMENTS

7.1 SUMMARY

This research has focused on developing an adaptive fault tolerant mobile agent system for efficient and reliable information retrieval. In this work, the information from the resources distributed across the network is retrieved, using mobile agents. The various issues that a mobile agent may face during its travel are identified and the corresponding solutions are proposed by this system. In this work, a centralized location server based dynamic travel plan that helps the mobile agent in order to select an optimal node dynamically, is proposed. By this dynamic migration, this work is able to retrieve more relevant information in less time, when compared to other related dynamic travel plans. The system proposes a memory allocation algorithm which provides more space for mobile agent accommodation. This is achieved by removing all the unattended mobile agents that unnecessarily occupy memory for a long time. The system also proposes a novel security mechanism which protects the legitimate mobile agents as well as the hosting platform from the malicious mobile agents. In order to recover a mobile agent in the event of its failure, this system presents a failure recovery model that recovers the failed mobile agent with data. This system ensures that failure recovery is achieved with reduced number of replicas, trip time and network load.
7.2 CONTRIBUTIONS OF THIS RESEARCH

The following results have been reached and are presented:

- A comparative study based on the performance of the mobile agent system over the traditional client-server approach was made for an information retrieval application.

- It is observed that the free-roaming mobile agents are able to reduce the network traffic and the overall trip time during the information retrieval process. For the tested environment, the mobile agent system reduces the data transaction of 2314 MB over the network to 37 MB, which is an 85% reduction in link usage.

- A location server based travel plan was designed for the mobile agent to dynamically select the next optimal node on the fly.

- The experimental results of the tested environment show that the number and size of the relevant documents retrieved by this travel plan for any given deadline are always higher than those of other travel plans.

- It was proved that the location server based dynamic itinerary is able to complete the given task of retrieving 100 MB of data in 13.32 minutes, a 13% of time is saved than the greedy approach that completes the task in 15.40 minutes.

- A memory allocation algorithm was developed that removes an excessively duplicated mobile agent and ensures more accommodation for incoming mobile agents.
• For the defined test condition, it was proved that this algorithm is able to accommodate twenty one mobile agents in addition to the normal allocation. Similarly, it was shown that an incoming mobile agent is accommodated by four nodes in addition.

• An attack specific security mechanism was developed in order to protect the mobile agent from other mobile agents. This mechanism is able to achieve 36% efficiency in the event of malicious agent detection.

• A failure recovery model was designed in order to recover the mobile agent, and was compared with related models based on the parameters such as trip time, network traffic and storage usage.

• It is clearly observed that in the MAFRAM model, the mobile agent migrates back to the home server in 1.50 minutes after tolerating two node failures out of six nodes. However, the mobile shadow design took 3.15 minutes, an increase of 1.25 minutes, for the same. The experimental results show that the benefit of the MAFRAM model is consistent even for an architecture with a large number of servers.

• It was proved that the network traffic for this model is minimum and constant in a fault-free environment. For the defined test condition, the maximum amount of data transferred by this model is 20 MB in a failure situation. However, the network traffic of other models is very high during failures, and those models neither supported multiple failure recovery, nor were implemented in a multi-region environment.
• It was shown that this system outperforms other models even for the criteria of storage usage and the number of replicas, and the result is consistent for a large number of servers also.

• Other works in this area have presented a basic domain specific mobile agent system, but this work has developed a mobile agent system with an efficient dynamic travel plan, at the moment usage memory allocation algorithm, a novel attack specific protection mechanism and a failure recovery model that survives any number of failures.

### 8.3 JUSTIFICATION FOR THIS STUDY

The mobile agent based information retrieval system first provides a dynamic travel plan for the efficient migration of a mobile agent. Using this travel plan this system determines an optimal node for migration on the fly using a centralized location server. Moreover, it retrieves the required relevant information in less time when compared to other travel plans. In general, the mobile agents that are created or cloned in large numbers are left unattended even after their task completion. Unlike other works, this system removes such mobile agents and provides more space for the comfortable accommodation of the incoming mobile agent.

Generally, most of the security mechanisms have concentrated and worked on the security of the mobile agents from the host and vice-versa. In this work, in addition to accommodation, the mobile agents are protected from other malicious mobile agents. In order to achieve this, the M-MASIR uses a specialized directory server that manages the required cryptographic keys and node information. With regard to the mobile agent failure recovery, most of the available failure recovery models focus on single node failure. The MAFRAM model uses information sharing method for ensuring failure
recovery in the event of multiple and continuous node failures. The overheads of the existing works such as witness dependency, replica maintenance and network load are comfortably reduced in this system. Most of the previous works have provided individual solutions for the various issues that arise during the mobile agent’s travel. Moreover, all the proposed solutions have their own limitations. However, as the first of its kind this work has proved experimentally that the M-MASIR can be used for efficient and reliable information retrieval.

8.4 FUTURE ENHANCEMENTS

There are many features that can be further improved in the work, for various other issues. Reliable communication is one of the important requirements of the system presented in this work. Any mobile agent system must indeed consider the failure of a node, link and application. However, this work has confined its limits only to consider node failure. This study provides a greater scope to consider failure recovery in the event of link failure.

This work assumes that node failure is temporary and recovers within a known period. Moreover, if the node failure is permanent, this system does not provide a way to retrieve data from that node. In that way this work is limited to the recovery of only the mobile agent. In future, this system can be enhanced with a failure recovery model that considers the recovery of node failure, and thus, the retrieval of information from that node.

The information retrieval domain implemented in this work is based on user queries. However, issues like query formulation, query expansion, comparison, ranking and document presentation are not focused in this work. Taking over the research in this direction is another scope that can be derived from this work.