Implementation

6.1 Introduction

Previous chapter described the design aspects of the AIS including the main modules and their main components. In addition, it also emphasised on the functionality of each and every component, how they interconnected, how knowledge bases and ontologies were designed, the nature of information stored within the knowledge bases.

In this chapter, we present the implementation details behind each and every module. Similarly this section also reveals the information related to technologies, tools and frameworks behind the implementation of each module.

6.2 Communication Module

Communication between front end uses and back end agent module has enabled by the communication module. It has been implemented purely using Java 1.5 Standard Edition (J2SE) [25]. Today Java is one of the most popular programming languages in the world.

6.3 Agent Module

Agent module is the most complex implementation in the system. It consist different types of agents, ontologies, knowledge bases and message console. Various technologies were used for this implementation.

6.3.1 Agent development

Java technology was used for agent development. This was done with the help of agent development framework known as MadKit [17] which is a Java based multi agent development environment. Agent Group and Role (AGR) was developed by using MadKit.

AGR model facilitated the basic functionality of agent development, management and communication and it was considered in three separate levels. Creation of agents was also carried out using MadKit.

Agents were defined as a group in an agent community who may have specific defined roles to play. This model speeded up the process of developing agents and assigning their functionalities, at the same time it simplified the agent communication as well.

MadKit is a free open source software distribution on GPL/LGPL license and it facilitate peer to peer communication model and allows developers to define system specific communication protocols if required.

6.3.2   Rule Processing Engine

Jess [15] has been used as the rule engine which handles the highly dynamic requirements, especially with the market agents. Rule processing functionality is carried out with the support of both MadKit and Jess.

Jess is a scripting language developed at Sandia National Laboratories in Livermore, California in the late 1990s. It was developed using Java technology therefore it is an ideal tool for adding rules to Java-based software systems. Jess supports the development of rule-based expert systems which could be tightly coupled with a system written in Java [14]. It uses the forward chaining mechanism when it comes to inference. At the same time Jess is faster than some popular expert system shells written in C language. Especially when it comes to larger problems, performance is dominated by algorithm quality.

6.3.3   User Information

Users are allowed to register with the system through the web interface. After the registration they can add information related to their cultivations. These information need to be managed and stored which is facilitated with MYSQL database management system.

6.3.4   Ontology Designing

Designing of ontology is considered as one of the complex task which require broad spectrum of knowledge in the problem domain of which ontology being developed. There are various approaches and tools available to facilitate this development. Various approaches have been used in designing ontologies and well defined standards also available.

a) Protégé

Protégé [21] is an open source ontology editor and a framework for knowledge-base creation. It facilitates all the required functionalities with the ontology designing and development process with the help of two main ways of modelling ontologies via the Protégé-Frames and Protégé-WL editors. Protégé also provide the ontology definition according to various standards such as RDF, OWL and XML scheme. Protégé is based on Java, and it is extensible and provides a plug-and-play environment that makes it a flexible base for rapid prototyping and application development.

b) XML

XML is a text-based language, where items are tagged in a hierarchical manner. It can be considered as the simplest way of designing the ontologies and to represent knowledge bases. It provides a syntax which is both machine and human readable.

c) Database

Information stored in a database follows strict standards of structure. It is a must to finalize the structure of a database during the designing phase and it is not allowed to alter afterwards. However when it comes to ontological designing, some of the ontologies can fit to this model of database designing. For example with AIS, System agents use an ontology which contains the knowledge about users and their cultivations. It is possible to observe that the structure of this information does not change over time and could be consider as fixed.

The database representation also used during the development of ontology. MYSQL [19] used as the Database Management System (DBMS) and it is considered as world's most popular open source DBMS.

6.3.5 Knowledge base implementation

Knowledge base implementation totally depends on the implementation of the ontology. There have been many approaches available depending on the ontological representations.XML related ontology itself contains the knowledge base.

When it comes to Database related ontology representation, database itself can be used as the knowledge base. In AIS implementation, system agent uses a database related ontology and knowledge base.

6.4 System Access Module

Java server pages (JSP) used to develop the web front end of the system. JSP a technology by Sun Microsystems has been widely utilised in developing dynamic web pages. JSP allows the possibility of adding java code directly into HTML files which makes the development process easier.

6.5 Deployment

Apache Tomcat web server [27] was used to host the application. Tomcat is an open source software implementation of the Java Servlet and Java Server Page technologies. It is an open and participatory environment and released under the Apache License version 2 and a well recognized web application hosting environment across a diverse range of industries and organizations.

6.6 Summary

This chapter presented the information related to implementation of each and every component and modules of the AIS. It described the technological information such as programming languages used to implement the system, tools which were used, information related to frameworks and standards which were followed during the implementation process.

After the implementation, it is essentially required to test and evaluate the system and its functionalities. In the next chapter we are presenting the procedures and methods used to evaluate the system.