Abstract

Chapter 1 introduces the overall healthcare scenario in India with special emphasis on children living in rural areas. The infants and children living in these areas are deprived of healthcare facilities due to paucity of funds as well as trained staff. The gravity of this deficiency is reflected in Infant Mortality Rate that is at alarming level. This problem can be plugged using software agents. An agent is a software entity that emulates the behavior of a user or of a service provider. The collection of such distributed, autonomous programs forms Multi-agent System (MAS) wherein service is provided at different locations. This chapter also includes a discussion on the application areas of agent oriented technology.

Chapter 2 reports a detailed review of literature that is conducted to understand the already developed MASs in healthcare. Apart from this, a medical diagnostic protocol developed by WHO for India is also studied. A number of researchers developed MASs for diabetic care, for organ transplantation, etc. But there is no MAS, specifically dealing with childhood diseases in the world. It is also observed that agent(s) must show decision making capabilities. Therefore, work related to these techniques adopted by agent(s) of various MASs, is also studied. Bayesian Network (BN) technique is studied extensively. Neural Network (NN) based decision making is also reviewed.

Chapter 3 discusses the proposed MAS model at abstract level to understand the roles and responsibilities of agents. The system is named as MASICC (Multi-agent System for Infant and Child Care). To construct different types of agents, it is required to understand the underlying childcare problem and the main contributory diseases to high IMR. With this understanding, a MASICC is envisaged in which location of
agents and their capabilities are defined. It is decided that agents need to share knowledge amongst each other and should be capable to respond under uncertain circumstances. The uncertainty arises when more than one agent can be selected to respond. Hence, an agent needs to demonstrate capability to select the most appropriate agent from a set of agents.

Chapter 4 describes the specifications laid down by ‘The Foundation for Physical Intelligent Agents’ (FIPA) for agent communication. These specifications are followed in MASICC. The agent at rural area is termed as User Agent (UA) and the agent at urban areas is called Intelligent Pediatric Agent (IPA). These agents form client-server architecture for knowledge sharing such as sign-symptoms, treatment plans, etc. A basic question – answer type of environment is created so that it should emulate the real-world scenario. To understand the structure of the communication between agents, a set of mathematical formulations is developed. To provide an overall working of the MASICC, an application scenario is crafted in which, UA sends the most prominent sign/symptom to IPA, IPA in turn asks for status of various other sign – symptoms. And finally, based on the inputs received from UA, IPA decides the treatment plan(s).

Chapter 5 expresses the design of the MASICC. There are two aspects of the MASICC design: Knowledge Sharing between agents and Decision making by an agent. To establish communication between agents there is a need for a common framework called ontology. The shared ontology determines how particular message content is to be interpreted by agents. Hence for knowledge sharing, childhood disease ontology has been designed for UA and for IPA. The IPA is supposed to select a Super Specialist Agent (SSA) for consultation in case where it finds difficult to diagnose on its own about the disease and its treatment plan as per the sign-symptoms supplied by UA. A BN based decision making system and Neural Networks based systems are designed to help IPA decide the appropriate SSA. To
develop NN based decision making system, a database of a childcare center has been collected. The dataset contains the sign-symptoms and the super specialist contacted by a qualified pediatrician. Both the techniques, BN and Probabilistic NN, help in reaching to the same decision.

Chapter 6 describes the implementation details of the system. The MASICC is implemented in Java and Jade. Jade (Java Agent Development Environment) follows the FIPA standards for agent communication. It is used for creation of agents through a middle-ware. Java classes implement the childhood disease ontology that specifies the vocabulary of diseases and treatment plans for agents. This vocabulary also contains the information of registered agents. The agents use standard communication KQML performatives like, request, query_ref, subscribe, inform, etc. The GUI of UA and IPA is constructed to help healthcare practitioners. The system is verified against a medical diagnostic protocol suggested by the WHO.

Chapter 7 deals with the implementation of decision making techniques. For developing the BN based algorithm for IPA, jSMILE libraries are used. jSMILE is a set of a platform independent library of Java classes for reasoning probabilistic networks. To validate the BN based decision making, a questionnaire was developed and distributed to pediatricians. Then based on the data received, a non parametric statistical test has been conducted. The result is satisfactory and suggests that BN can be effectively employed. To demonstrate the utility of NNs in the same scenario, a NN based algorithm is designed. This algorithm is developed in MATLAB programming.

Chapter 8 summarizes the main accomplishments of this thesis and discusses the advantages of using agent technology in this application scenario. It is found that this technology can be applied to provide healthcare facility to remote areas. The intelligent agents emulate the behavior of doctors, hence minimizes the requirement
of trained staff. It is also demonstrated that BNs and NNs techniques are effective in handling uncertainty in the selection of agents. This research work is specific to childhood diseases only, whereas it can be extended to include other healthcare problems too.