Smart travel service advisor using Semantic Web and Agent Technology

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Abstract: - Tourism is travel for leisure and recreational purposes; however, it becomes difficult for tourists to pick the right destination and the right tour company from the wide variety on offer. Tour companies promise to provide better services than their competitors and show that their clients are fully content with their services. It is also difficult for the new user to inquire on and validate a company's reputation and past experience with that company. This paper discusses software that has been developed to tackle this problem. The Smart Travel Service Advisor (STSA) uses Agent technology with the Semantic Web environment, and provides results with which to scrutinize the travel companies' reputations. STSA's main purpose is to help clients by providing them with up-to-date information about travel companies' performance and help them choose the right company according to their requirements and preferences.

Key-Words: - Tourism, Semantic Web, Software agents, Ontology, Smart Travel Service Advisor

1 Introduction

According to predictions of the World Tourism Organization [1], tourism will increase by 200% by 2020. The tourism industry has become a competitive business all over the world, and travel companies are trying their best to take full advantage of this opportunity. Marvels of information technology have made individual choice for travelling to different destinations very easy, but at the same time have overloaded the user with excessive options. Thousands of websites are now available offering a variety of options, with cutthroat competition between them. Most industries are making use of the Web and related technologies to facilitate their business and help their clients.

Intelligent software programs are being used to help users with personalized information. Agent Technology is contributing most in the field of intelligent software. Multi-agent systems are distributed software entities that cooperate or compete to achieve individual or shared goals. Agents encapsulate their behavior and are 'motivated' by their internal goals. The agents can respond individually, pro-actively and reactively, to changes in their environment. The agent metaphor is one approach to creating software systems that are capable of solving distributed problems. This proactive software requires much less human support. These agents have the ability to take decisions, execute plans and achieve the required goals. According to Shoham [2], "*An agent is an entity whose state is viewed as consisting of a mental component such as belief, capabilities and commitment.*" We are moving towards a new era of computers capable of their own decisions, which are not completely dependent on humans for accomplishing their tasks. Rather, they can also assist humans by supporting their daily tasks. Use of intelligent software agents has increased recently. The term *agent* is used widely, and covers the personal assistant [3], smart interface [4], and intelligent information retrieval system [5].

The Semantic Web is a group of languages and models that make the existing web *intelligent*. Ontology plays a very important role in developing a common understanding of information among humans and software agents. These are the reasons to use ontologies:

- To share common understanding of the structure of information among people or software agents.
- To enable reuse of domain knowledge.
- To make domain assumptions explicit.
- To separate domain knowledge from operational knowledge.
- To analyze domain knowledge [6].

2 Problem Statement

Travel packages are offered by different companies who promise many 'goodies' in order to entice a client to choose their services. Usually clients look at the following questions before making any selection.

1. Why should I choose this company and how can I examine its previous performance?
2. Are previous clients satisfied with the services that were offered, and what is their feedback?
3. How can I compare different packages offered by different companies?
4. How reliable and efficient are their services?

Assuming that travel companies are equipped with agent-based software and offer automated intelligent solutions, the question arises how customers can get maximum benefit from these solutions and how customers would get to be aware of this? These are the questions that STSA will try to handle and, in doing so, will provide a clear picture of the company's current and previous history.

We are proposing an agent-based solution for the above-mentioned problem. The reason for using this approach is to answer the users' queries intelligently and to suggest the most feasible and appropriate list of service providers to them.

3 Related Work

Ting Li *et al.* [7] talk about the need to spread the concentration of peak period travel. The method used to reduce the peak travel requirement and increase capacity utilization, is "dynamic pricing" [8], which is the most popular revenue management method. Kruszyk *et al.* [9] introduce the concept of collaborative content filtering. Their work focuses on the development of an agent-based travel support system, in which personalized information is delivered to the user. Baladarshan and Enkhsaikhan [10] present the use of a multi-agent system for the travel industry. Their paper discusses the use of information sharing. Travel agents do not share information about their clients with other agencies, as this information is critical to their business policies, but may be made accessible to a limited number of companies, not the whole industry. Yeuh *et al.* [11] discuss the problem faced by the client while planning a tourist search for information from different sources like web sites, knowledge bases, etc. The issues are related to customer service and planning management. The local tour planning process helps the tourist when he reaches his destination. Repo *et al.* [12] examine the development of the business-to-business mobile service (B2B) into the business-to-consumer service (B2C). The focus is now on how the product development process can be enhanced through active involvement of the user. The mobile service selected for testing purposes was designed in a business tour context, but they transferred the service into the leisure context.

The objective of the study of Horan *et al.* [13] is the delivery of information by the government to the citizen through electronic means, based on user satisfaction. The Advanced Traveler Information System is a service offered by the government to its citizens. The goal is to evaluate the satisfaction level of citizens, utilizing the services offered by the government for trip planning. Huang and Lin [14] propose a system that effectively and quickly calculates the approximate shortest distance route. There are $N!$ routes for a tourist to visit N cities. The problem is to determine the shortest possible route that can allow the tourist to pass through every city exactly once before returning to the departure city. This Approximate Shortest Distance Route Intelligent System for Traveling integrates the Hungarian Method and the Branch-and-Bound Method in Operations Research, and Nearest Neighbor in Data Mining.

Park *et al.* [15] discuss the context-aware tourist guide. They have developed a PDA-based location-aware tourist guide, which works as an assistant to guide tourists round the old palaces in the center of Seoul, Korea. Li *et al.* [7] talk about the traveler behavioral model in railway simulation. Kruszyk *et al.* [9] focus on personalized content delivery for travelers.

None of the solutions presented above provide a way to find those travel companies that suit an individual's travel requirement and who present results based on their users' experiences. Our solution presents a complete methodology for searching for the requirement within specific travel companies, with the focus on the company's previous performance and satisfied users.

4 System Infrastructure Overview

Tours and trips are arranged by travel companies. There are many travel companies in the market offering diverse services.

From a user perspective, choosing a travel company, which fits the user requirement and preferences, is not an easy task. Either the user will surf the web and spent days selecting, analyzing, discussing and finally choosing a travel company, or will personally

view is completely separated from the model, using a Controller as an intermediary. If we separate the different parts of the MVC, we will find a structured and organized mechanism for routing different requests to their respective destinations. Separation
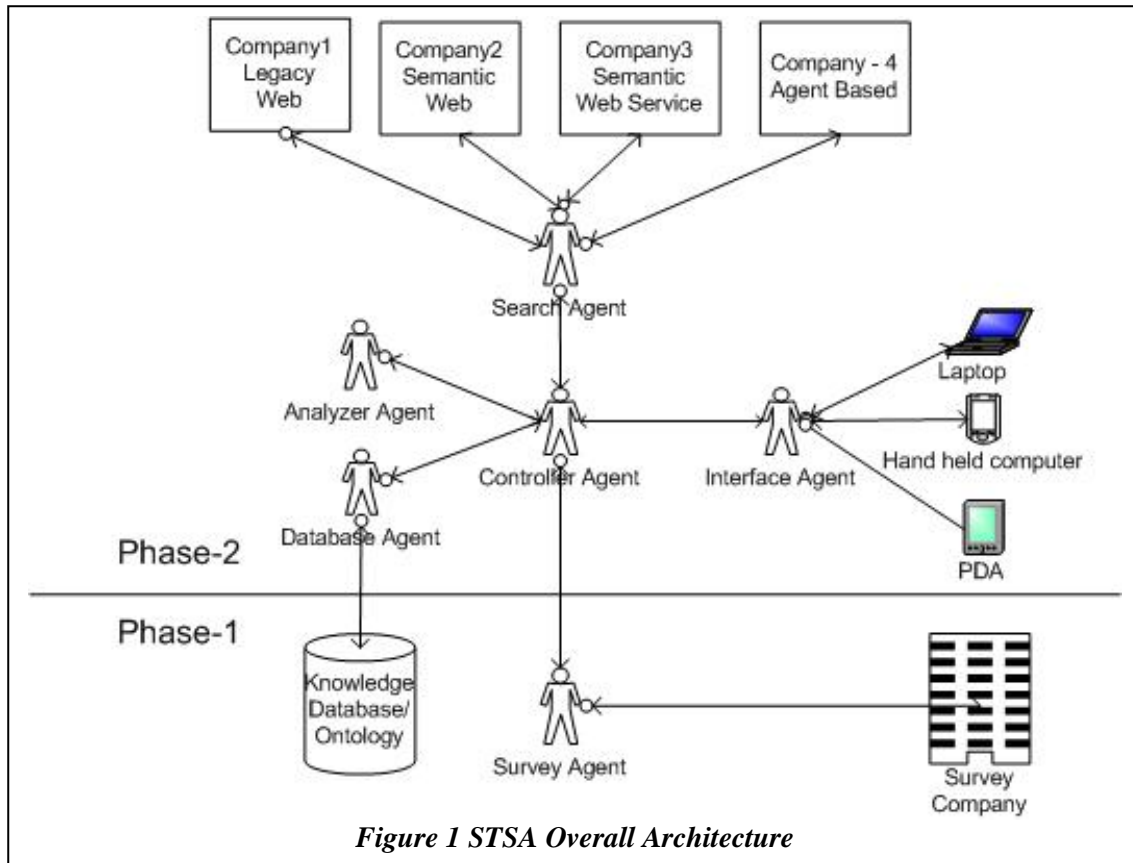

Figure 1 STSA Overall Architecture

contact each company's local office, to gather information. Both ways are time-consuming and this individual effort will not necessarily yield the required result. Even with this effort, the major drawback of the traditional way is that the user does not know about the company's quality of services. It is very difficult to determine those clients whom the company has already served, and have been satisfied with the services offered.

The Smart Travel Service Adviser (STSA) is an agent-based solution for searching requirements-based travel companies, and it is focused on the User Satisfaction Level (USL). The final result depends on the USL provided by the users about the companies. STSA is a 2-phase advisory solution. In Phase 1, different surveys are conducted by involving different public and private sector organizations. Phase 2 is a search and analysis process in which different companies are searched by the agent, according to the user's requirements, and analyzed based on their USL, as shown in Fig. 1.

A Model View Controller (MVC) design pattern [16] is applied for structuring the application. The

of responsibilities helps the Application Programmer (AP) and Designer directly. The AP can code his logic while at the same time the Designer can use his creativity on new designs and make them available for the AP to show his desired results. The Java Jena Framework [17] is used for persistence and to retrieve the data ontologically. This enables Semantic Web applications to be written. It includes

- An RDF API
- Reading and writing RDF in RDF/XML, N3 and N-Triples
- An OWL API
- In-memory and persistent storage
- SPARQL query engine

Believe-Desire-Intention (BDI) [1] agents are being used. They are a particular type of "bounded rational" software agents, which can monitor environmental changes and update their information. Philosophy is the root of BDI agents. They are based on the mental attitude, i.e. belief, desire and intention. These concepts helped in producing human-like intelligence.

5 System Design and Implementation

As discussed earlier, the solution is divided in two phases. In this section, we will elaborate the core of the system design and show the different agents and processes involved, as shown in Fig. 1.

5.1 Phase 1

This phase focuses on the survey process. The survey requires knowledge and expertise of the people involved in the tourism domain. The survey will be conducted by people from diverse disciplines including corporate, finance, education, business, information technology, etc. The purpose of the

budget, duration and destination. This information will be stored in the knowledge database.

5.2.2 Search Process

At this point, the Interface Agent (IA) requests the availability of a Search Agent (SA) from the Controller Agent (CA). The IA forwards the user's profile to the SA. The IA assigns the user characteristics and requirement to the SA. The SA now acts as the user and searches for the most appropriate service providers. The tourism ontology is being partially created using the Protégé [18] tool. Protégé is also used to construct the domain model

Figure 2 UML model for Phase 1
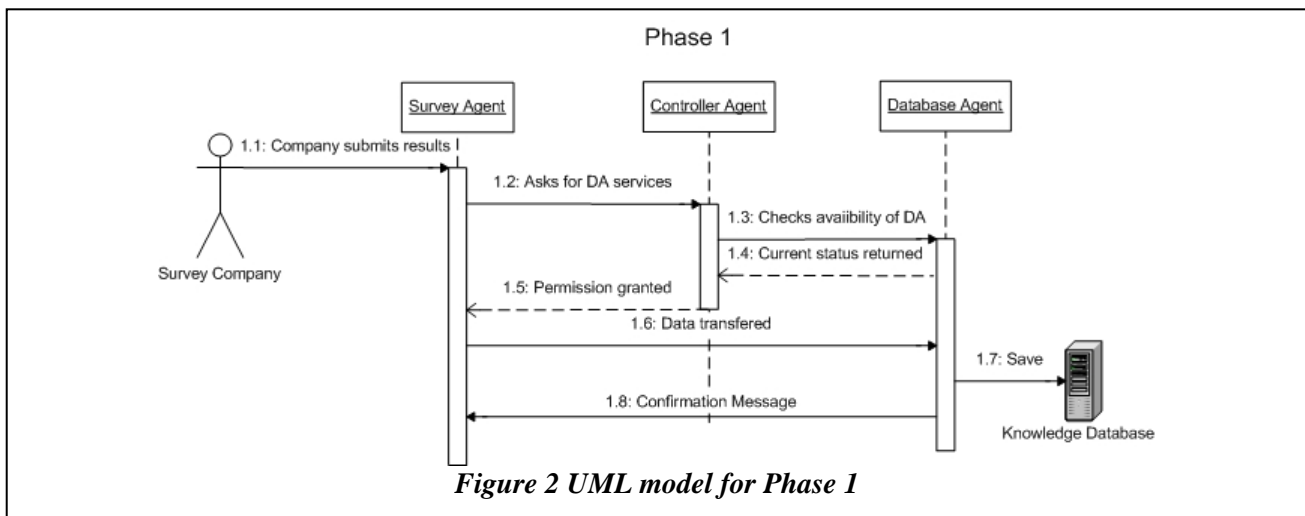
survey is to gather and judge the User Satisfaction Level (USL) of current and previous tourists. The USL parameter includes destination, budget, type, etc. This USL parameter will help us to analyze and rank the travel companies. Fig. 2 shows the UML model of this process.

5.2 Phase 2

5.2.1 User Assessment and Requirement Process

This process assesses the user's personal characteristics and travel requirements, and is divided into two steps.

Step 1 Personal Assessment. This step analyzes the personal disposition, which plays a major role in the decision-making. This could include age, income, education, dependents, etc. Information will be securely stored in the knowledge database, with the client's permission.

Step 2 Travel Requirement and Preferences. The user provides his/her travel preferences such as: type of tour (economy or luxury), class of hotel, value added services, etc; and requirements such as:

and knowledge base using ontologies. Web crawler agents will be used to extract information from legacy web sites. Web crawlers can simulate a user accessing the target website. We limit the results from the SA to the 10 companies best matching the requirements. The information will be stored in the knowledge database.

5.2.3 Analysis Process

The 10 selected companies will be compared according to their USL parameters. After getting permission from the CA, the SA forwards the results to the Analyzer Agent (AA). The AA analyzes each company and ranks it. The ranking criteria are based on travel preferences including destination, budget, type, etc.

6 Experimentation

The following screen shots are taken from the experiment. We have chosen as an example the origin and destination to be located within Pakistan.

Scenario
A person living in Karachi wishes to visit the

Northern Areas of Pakistan. He has the budget of Rs.50,000 and has 10 days for his trip. He wants to know about travel companies, and different package offers satisfying his requirements.

Results from the STSA (Fig. 3) show a number of companies offering packages near the total estimated cost. The result will be shown to the user after searching for the most appropriate company and ranking the results based on User Satisfaction Level.
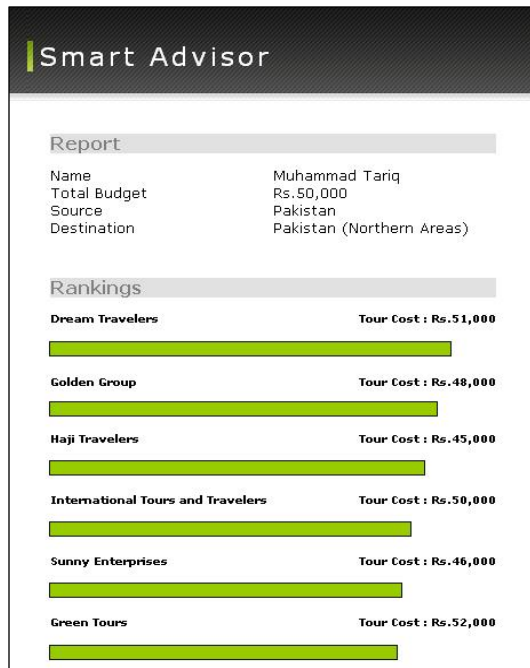

Figure 3 Final result

The user will click on the company's name to see the tour information offered by it. Fig. 4 shows the display when the user wants to see the different packages offered by other companies. The user will click on the company's name, and brief tour information will be shown to the user.

Fig. 5 shows the detail of each day's activity on the tour. This helps the user compare and decide between company offers. Fig. 6 shows the itinerary for Day 03 to Day 06.

7 Conclusion and Future work

In this paper, we present an agent based solution, which helps its users in the decision-making process before finalizing a service provider. The ability of agents to acquire information and to behave like the user, shows their strength, and helps the user since the agent acts on behalf the user in order to bring about optimal results.

There are some issues needs to be addressed. The communication language between the Search Agent (SA) and other agents on the internet needs to be standardized. Search optimization techniques can be
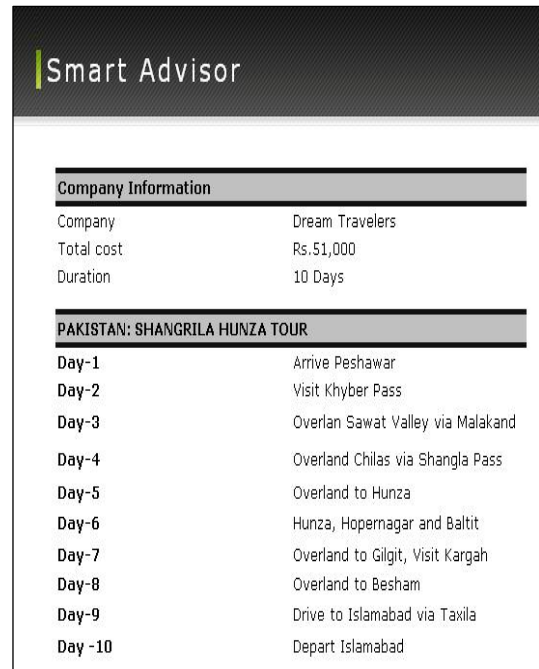

Figure 4 Brief tour description

used for better performance.

In future, we will like to focus on the behavioral changes during the tour, based on pricing and destination. New services will be incorporated such as financial and self-trip planning. Financial services will be helpful for tourists who have a limited budget and want to explore different finance options available. Self-trip planning provides the facility for tourists to plan their own trip as they wish. Complete information will be provided to the users to plan their tour.
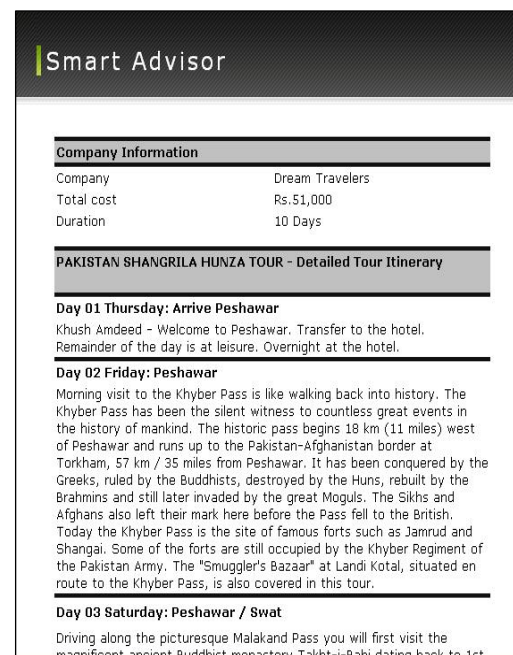

Figure 5 Day by day detail

Day 03 Saturday: Peshawar / Swat

Driving along the picturesque Malakand Pass you will first visit the magnificent ancient Buddhist monastery Takht-i-Bahi dating back to 1st to 7th Century AD. Takht-e-Bhai consists of numerous chapels and stupas sticking to the high, rocky spurs. Next continue to the enchanting Swat Valley visiting the famous Churchill's Picket en route. Later a city tour of Saidu Shariff, the capital of Swat Valley. You will see the small, but well preserved Swat Museum and Mingora known for its very colorful bazaar and Marghazar.
Overnight at the hotel.

Day 04 Sunday: Swat / Chilas

In the morning ascending north, you cross the 2134m Shangla Pass, which gives a breathtaking and panoramic view of the Swat Valley before getting along side the Indus River on your way to the Gilgit Valley. Remainder of the day is at leisure.
Overnight at the hotel.

Day 05 Monday: Chilas / Hunza

Driving on the world famous Karakoram Highway to Hunza you will see spectacular scenery with high lofty mountain, first from the Himalayan and later from the Karakoram ranges. En route stops at various scenic spots and local villages. The exalting scenery en route does not prepare you enough for the majesty and serenity that Hunza Valley will behold on you. On arrival to Karimabad, the capital of Hunza Valley, you are welcomed by the Hunzakuts. Remainder of the day is at leisure.
Overnight at the hotel.

Day 06 Tuesday: Hunza

Full day tour of Hunza. Very few places in the world compare with this small mountainous region, which was a semi-autonomous state until very recently but is now fully unified with Pakistan, the ruling dynasty of Hunza having lasted for over 600 years. The scenic beauty of this area, with its greenery and snow-capped mountains, makes it a true paradise. During the summer there is an abundance of apricots, peaches, pears and grapes. Hunza lies on the ancient trade route to Kashgar in the Chinese province of Sinkiang. Today the Karakoram Highway runs along

Figure 6 Continued Itinerary

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