BUILDING A CONTEXT-AWARE MOBILE TOURIST GUIDE SYSTEM BASE ON A SERVICE ORIENTED ARCHITECTURE

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ABSTRACT:

The term of *context* in mobile computing area especially in the spatio-temporal applications introduces a rich source of information, yet it has less been regarded and modelled in the related fields. Since a tourist may be considered as a moving object in an environment with variable contexts, therefore tourist guide applications and services is taken into account as an application area for the context-aware systems. To implement such a dynamic service-based applications, in this paper, we propose a framework for personal tourist guide (PTG) system based on service oriented architecture (SOA). In our proposed framework, PTG send a request based on the context of user to a catalogue. Service brokers collaborate to find the right services and then, PTG and service provider negotiate as to format of the request and some other protocol issues. At the last step, tourist may utilize the provided services. To evaluate this framework, a simple case study was developed. The results show its superiority over the traditional architectures.

1. INTRODUCTION

The World Tourism Organization defines tourists as *"people who travel to and stay in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes not related to the exercise of an activity remunerated from within the place visited"* (UNWTO, 2007). According to this general definition we may immediately reason that unfamiliarity is the main specification of a tourist. There are several solutions for this problem. Among them, one traditional solution is using the information centers. These centers are throughout the city especially the center and more populated parts of it and offer oral and written helps to the tourists. Although these centers provide useful and applicable information for tourists, but these information providers are not accessible any time anywhere. Tourists may wish to change their schedule or re-plan their itinerary as some conditions or context parameters change. Thus, a ubiquitous and pervasive tourist assistant plays a key role in development of tourism industry.

Over the last two decades, progresses in information and communication technology especially in hardware development result in smaller, cheaper, and faster computers. One of the main effects of this evolution was appearance of new generation of handheld and palm-sized computers in different forms of smart cell phones, PDAs, pocket PCs, etc. The prominent characteristics of these systems are their small volume and light weight which made them more useful in mobile computing.

One major application area of these systems is in tourism field, where a tourist may be assumed as a mobile and moving object. Mobile tourist guide systems may assist tourists both in the preparatory phase and during a trip. If the context elements are added to these systems, they may present more relevant information based on user preferences and the context (e.g. his/her current location or time). Using the context components is of importance from the other aspect. Since a mobile device suffers from several limitations such as small screen and network connection with low bandwidth, it is important to select the suitable quantity and quality of information that is presented to the user. Using the contexts information let the system to decide about the suggested information to its users which is more satisfactory for them.

Up to now, many context-aware tourist guide systems have been developed. A comprehensive and thorough review of these systems may be found in (Schwinger et. al, 2005). The common technology used in the commercial tourist guide system to connect between user and data providers is the well-known client/server architecture. Using this architecture, users may encounter some drawbacks. For example, if they wish to find a suitable service, they have to search the entire service providers to find the most relevant and right one. In some cases, it is impossible for a user because of limited resources (e.g. time). Thus, we feel the need to a mediator as service mach maker between a tourist and relevant service providers. The service oriented architecture may be considered as a suitable candidate to replace the client/server architecture.

In this paper, we propose a framework to implement a context-aware personal tourist guide system based on service oriented architecture. The paper organised as follows. In section 2, we define the concept of context and introduce the context-awareness. In part 3, the proposed methodology is explained. The evaluation of the proposed framework is introduced in section 4 with some results. Finally the last section includes the conclusions the paper.

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2. CONTEXT AND CONTEXT-AWARENESS

Although Context is an important concept in ubiquitous and pervasive computing and play different roles in mobile computing area, but it has been less utilised in this field. There are not any comprehensive definitions among the researchers. Some of them have elaborated on defining context by enumerating examples of it (Schilit et. al,1994; Chen and Kotz,2001). This sort of definition is difficult to use practically. On the other hand, some of the researchers have tried to present a comprehensive operational definition of the concept. Among them, the definition proposed by Dey et al. as *"Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves"* looks a useful starting point for implementing the context in the applications (Dey, 2001).

The context could be divided into categories where deferent researchers have tried to present a comprehensive one in different application domain. Generally, the context may be classified into four main categories including computing/system (such as size of display, input method, network and communication cost and quality), user (such as people nearby, user's profile, socio-cultural situation), physical (such as location, lighting, temperature, weather conditions) and time (such as time of day, week, month). As well, the context history could also be useful for certain applications. The other classifications also suggested by researchers from their application fields points of view.

Dey also defined *"the system to be context-aware if it uses context to provide relevant information and/or services to the user, in which the relevancy depends on the user's task" (*Dey, 2001*).*

In recent years, a large number of context-aware applications such as call forwarding, teleporting, active map, mobisaic web browser, shopping assistant, cyberguide, conference assistant, people and object pager, fieldwork, adaptive GSM phone and PDA, office assistant have been proposed and commercialized (see Chen and Kotz, 2000 for a review). Most of these systems are context-aware mobile systems which aim at delivering information and services tailored to the current user's context. The growing number of context-aware system and need to use them motivate most of the researchers to go towards this concept.

3. PROPOSED FRAMEWORK

Generally, tourists may find the answers to their necessary queries about the services and resources of the travelled city from two main ways (table 1). The main factor distinguish these two categories is their platforms. The commercial way does not use the computer whereas the other category uses computer.

Main category	Sub-category
Commercial	-
Computer-based	2-parts
	3-parts

Table 1. Margin settings for A4 size paper

Commercial category: As illustrated in figure 1, in this case, the tourists go to a tourist information centre and some expert helps them using his/her knowledge and some hardcopy resources (e.g. yellow pages). The major advantage of using this paradigm is its interactivity. Both the tourist and the guidance agent are human being and some vagueness in their interaction disappears. On the other hand, the information of the expert agent may not be up to date.

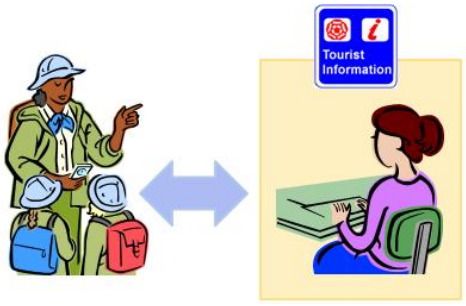

Figure 1. Commercial analogue tourist guide stations

Computer-based category: the emphasis in this case is on using the computer instead of/together to the human agent. This paradigm is classified into two main categories. In the first category, tourists go to a tourist information centre/kiosk and like the previous case, someone guide them. In contrast, in this case, a computer which is connected to a network of information servers are utilized (figure 2). Thus, the problem that the agent may have out-to-date information is resolved. One of the disadvantages of this paradigm is that it is more time consuming rather than the previous one.

Figure 2. Commercial digital tourist guide stations

The second category of second category is using a digital handheld assistance which has a connection to a network and some contexts sensors. The major advantage of this class rather to the others is its ubiquitousness. Most of the recent tourist guide systems are presented in this form.

As a system in the last class of tourist guides, we propose a 3-parts framework based on service-oriented architecture (Figure 3).

The key component of Service Oriented Architecture (SOA) is services. A service is a collection of actions. Services in SOA have some specifications. Services are reusable, share a formal contract, abstract underlying logic, and are loosely coupled, autonomous, stateless, and discoverable (Erl, 2005). Using this architecture are getting popular in different fields such as software development and GIS.

There are three types of key actors in SOA. These are service requestor, service provider and service matchmaker (which help the requestors to find the right services).

In this framework, a tourist uses a handheld device (e.g. PDA, smart cell phone, etc.) to connect the Personal Tourist Guide (PTG). As illustrated in figure 3, the contexts data are collected by contexts agents. When the tourist wishes to requests a service using the predefined analysis of PTG, e.g. planning a 4-hours tour, the related functions are called and requests are sent to the service catalogue. Since the catalogue have on-line and real time connections with service providers (e.g. museums, commercial centres, cultural centres, etc.), the catalogue find suitable resources of services according to the specifications of user and bind them to him/her. Using this architecture empower the user to find more suitable resources with less effort.

PTG consists of four main components as follows (Figure 4):

- Rule-base includes a set of rules, used to make a suitable decision according the contexts. It is updated by GIS engine using the derived and processed contexts and feedbacks of the user. In the trial version of system, this component is not used.
- GIS engine, is the central component of PTG. It consists of some algorithm to fuse and analyse the contexts information and digital maps/spatial databases to show the suitable results to user. Among them, we may refer to query on POIs, path finding and guides, and tour design.

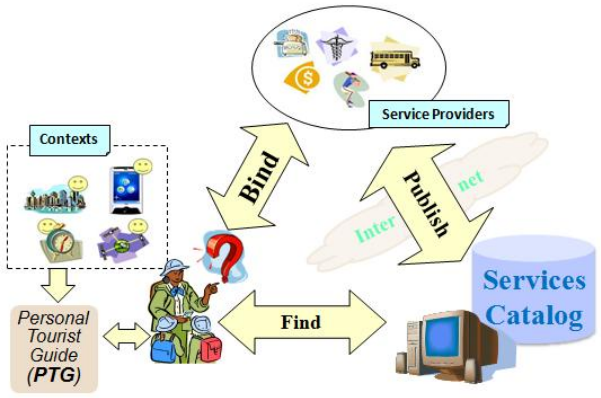

Figure 3. Outline of the proposed framework

- Context manager, collect the derived context data and process them. The processes may include deriving secondary data (e.g. derivation of velocity from position and time data), checking the collected data (e.g. consistency and correctness) and monitoring the context information. This part is also used to store the context information.
- SOA connector plays the role of a bridge between PTG and the external SOA framework. It may transfer the information from GIS engine to the output catalogue and vice versa.

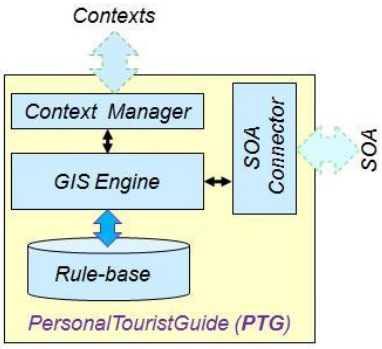

Figure 4. Main components of PTG

As a result, using the proposed framework, a tourist enables to utilize the tourist guide system anywhere without having the list of services. It also decrease the time of search and increase the probability of finding a suitable and corresponding services. In contrast to the similar commercial systems which are based on data and information, the principle concept of our proposed framework is service.

4. EVALUATION AND RESULTS

To evaluate the proposed framework, a light evaluation version of PTG was developed. In this trial, we provide a tourist with some functions to utilize the POIs (e.g. museums, car rent office, restaurants, trade centres, medical centres, etc.) and pathways (see figure 5). The used data was a part of the tourist map of Tehran, the capital of Iran.
The components of context used are location (collected by the GPS receiver), time (collected by the timer of pocket PC), and user (collected by a questionnaire and adapted by feedbacks of application). The information collected by context elements are stored and managed in context manager component.

Figure 5. Main GUI of PTG

Some general and frequent queries of a tourist inside a city such as planning a tour, searching for a POI, and overview the past trips map are searched by system to evaluate its efficiency. We show the flow of system by a sample. A tourist may wishes to

find the nearest restaurant which serves the traditional foods at 11:45 AM. To find a suitable answer to this query, PTG calls the context manager to add the contextual information. It requires the current position of user (to find the nearest poi), the time (to find the suitable meal) and the user's profile (e.g. age, diet, etc.). Then PTG seek the nearby restaurants and find some candidates which are just near the tourist and serves the traditional foods. The candidate restaurants as well as context information in a predefined format send to the service catalogue by SOA connector. The catalogue continues the query by searching for the satisfactory results. The catalogue works here as a matchmaker and have an updated and consistent metadata about service providers (here, restaurants). When the catalogue service attains the user-fitted results, it sends the service providers lists and format of negotiation. In our sample, the catalogue service utilizes the published metadata from service providers (such as open/close time, type of foods, etc.) and selects some restaurants according to the user's context from the candidate list and sends them to the PTG. At the last step, the GIS engine chooses the most suitable restaurant and recommends it to the user visually (Figure 6).

According to the results, although the restaurant looks farther than the others, but it satisfies the preferences and contexts of user.

If we have a comparison between the proposed architecture and the architecture of current systems, the advantages of SOA appear as follows:

- User may not need to know about the service providers' configurations and specifications, if they change their service or any providers are added/ removed.
- Since the catalogue service plays the role of match maker, thus, it provides the independence of users from providers. As it is not necessary for user to send his/her personal contextual data to service providers, therefore, the security level increases.
- The registry searches the service providers on behalf of the user. Thus, user takes less time to find a suitable service and the efficiency of the system increases.

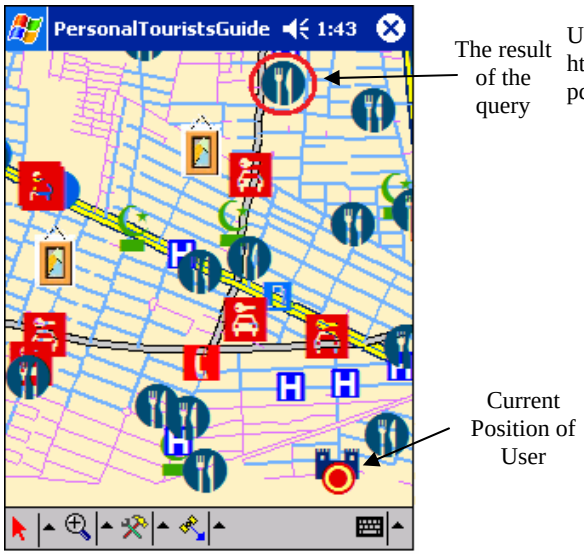

Figure 6. A query and its result in PTG

5. CONCLUSION

The evolutions in the mobile computing society have motivated the development of user-centric applications. Using the context-aware systems utilise the developers to fulfil this goal.
In this paper, we introduce a framework to use context in a tourist mobile guide assistant based on a service oriented architecture which shows its superiority over the traditional client/server architecture. To test the proposed framework, an evaluation version of a guidance system namely PTG was developed and evaluated by some common and frequent queries. Briefly, we may refer to independence of users from service providers and saving search time as the main advantages of using SOA in mobile tourist guides systems.
This work is in the first steps and we plan to develop the proposed architecture as a commercial system. Further works on this research is modelling and involving the vague user contexts in the requests sent to the service catalogue as well as using the feedbacks of user to results as training to improve the rule-base.

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