The Design of an Integrated Mobile e-Guide System for Tourism

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***Abstract*—This paper presents a web-based e-guide system for tourism using offloading and mobile integration. A user can search for new mobile services available on the website to use either remotely on the server where the services resides, or locally after downloading them to his/her mobile device and work offline without a mobile connection. The system aims to help the tourist accessing tourism information directly from his/her smart device, anytime and anywhere using offloading. It is a web-based electronic guide that provides the user with appropriate tourism information about Jordan and guides him/her to find the best places to party, eat out, and enjoy culture events. The system architecture and the main components of the proposed services were presented and discussed. The system has been prototyped and validated in a real-time mobile internet application scenario. The system also has been evaluated through simulations in a mobile network environment. Both experimental and simulation results demonstrated the effectiveness and efficiency of the proposed system.**

***Index Terms*—e-services, mobile commerce, mobile technology, tourism, web-based information system, wireless mobile computing.**

I. INTRODUCTION

The last decade witnessed a revolution in information and communication technology, which not only changed the daily behavior of the people but also affected their way of interaction with each other. New forms of services have emerged based on the new booming e-technology that is affecting all matters of our life. Information technology is changing the way of understanding many social and commercial interactions. Many corporations are taking new trends regarding information where people need not to move as far as information can. The integration of computers, internet, and mobile technology has allowed the emergence of new concepts in e-services. Even governments started utilizing the internet for delivering requested governmental information and services to citizens using a wide range of information and communication technologies. Recently, many of these services are becoming mobile-based, where the user can request and get information and services via smart mobile devices [1, 2].

Rapid advances in wireless mobile network technologies and mobile devices facilitate ubiquitous infrastructure that can support a range of mobile services and applications. One recent trend is to effectively run desktop PC oriented heavier applications on mobile devices. However, due to their limited capabilities and their mini portable size, mobile devices are resource constrained and therefore, running these applications directly on a mobile device is not satisfactory for the user expectations. To cope with this problem, offloading services are used to offload some of the tasks of a mobile application from the mobile device to a nearby PC server. New technologies in mobile and wireless applications attracted the attention of many organizations to employ them in their processes to enhance the quality of their e-services. Mobile services are becoming the future of many businesses as many users are relying on them, that is why many researchers are considering them as the strategy that all corporations must take for the future to be part of their business, regardless of the type of service they offer [3]. Mobile services are becoming essential to many sectors, whether it is education, commerce, or government [2, 4].

Many researchers showed that the use of ICT has helped enhancing the quality of the tourism industry in different aspects. In [5], the authors showed the benefits of ICT in tourism and presented models, strategies, and tools to achieve this, which was applied in different experiences in Italy, Morocco, and Jordan. Rayman-Bacchus and Molina [6] assessed the developments among internet-based tourism services, addressed key factors shaping the future of using ICT in tourism, and highlighted a number of implications for the further development of tourism electronic services provision within Europe, where internet plays a significant role. Schneider and Sonmez [7] pointed that developing countries like Jordan have few research attention devoted to tourism image despite the fact that image is a key factor in determining travel decisions to many tourists. The tourism image can be improved by enhancing services and marketing using ICT. Xiang *et al.* [8] addressed the growing importance of the internet and the significant impact of electronic services in the tourism sector. Kim and Fesenmaier [9] addressed the importance of assessing tourism websites and concluded that a website gives the first impression of a tourist destination. In [10], Kelly studied Jordan's potential tourism development and pointed out some problems that need to be resolved to improve the tourism sector, among them is the inefficient deployment of ICT.

This paper presents the design and implementation of a prototype web-based electronic guide system for tourism with mobile technology integration. The system offers a wide range of services and information about the tourism sector in Jordan that can be easily accessed by a smart device at any time and from any place. The rest of the paper is organized as follows. Section 2 presents a background and some basic concepts about electronic and mobile technologies. Section 3 presents the analysis and design of the proposed system. Section 4, presents the implementation phase of the system and explores the testing model used in the system. Finally, section 5 concludes the paper and addresses some future possible work.

II. BACKGROUND

The tourism sector has a direct impact on the economy of many countries like Jordan. Jordan is a young modern country dense with history and a well-traveled bridge between sea and desert, east and west. Jordan is an ideal destination for those seeking cultural knowledge and spiritual enrichment. It provides monuments from every age of the humanity, crowned by the rosy rock-carved city of Petra, a World Heritage Site. Petra and other Jordanian cities offer visitors beautiful holly and ancient sites [11, 12]. All of this made Jordan a major world attraction to tourists with a wide range of interests from all over the world. In the last few years, Jordan Ministry of Tourism and Antiques started employing ICT via their web site to market the ancient and religious sites in Jordan. The use of information and communication technology is becoming essential in enhancing the quality of services in many sectors including tourism [13]. It is not enough anymore just to publish static information on the website; rather you need to provide much more e-services beyond that [14-17].

Mobile devices are closing the digital divide in developing countries such as Jordan. These developing countries don't have the money to implement wired networks, but they can afford wireless networks. As a result, people can afford mobile devices, and with declining internet access fees, they can do wireless mobile commerce. Internet-based mobile technology and its related applications and services have progressed greatly in the past few years. While for many people, using specific internet applications would be more comfortable with large screen desktop, the mobility freedom provided by cellular and mobile technologies suggest the development of a closer connections to applications so that users can receive most of their communication needs from their mobile devices.

Various wireless mobile network technologies and their synergies are experiencing rapid development and deployment. The advancement of this technology enables ubiquitous infrastructure that supports a range of mobile services in addition to mobile internet access [2]. The further success of these network systems derives from their ability to provide users with cost effective services that have the potential to run anywhere, anytime, and on any device.

The new trend for internet-based client/server architecture where the mobile device acts as the client is booming in many applications. Fig. 1 depicts the wireless mobile environment, when computation goes mobile and communication goes wireless, which results the emergence of *wireless mobile computing*. Wireless mobile computing refers to a computing paradigm designed for users who travel outside the boundaries of their organizations or for anyone on the move. This new paradigm enables a real-time connection between a mobile device and computing networks anytime and anywhere. It offers a computing environment suitable for persons, who are in the move. A salesman can close a deal at the customers office away from his/her own office, a field service worker can conduct an inventory check for a faulty part and take actions, an executive person can communicate with his/her office and exchange important information online while away from his/her office, and a tourist can get information about interested places while on move. The innovation of mobile computing is creating a revolution in the manner in which people use computers at work, home, school, entertainment, and much more.

The mobile infrastructure considered in this paper is web-based with mobile integration. While service providers offer their services through the internet, mobile users are connected to the internet by various wireless access network technologies and mobile internet gateways. Users can search for new mobile services available on the internet and then use them, either remotely on servers where the services resides, or locally after downloading them to their mobile devices. Fig. 2 depicts the client/server system architecture for the proposed system. When services involve a huge amount of data usually local execution is a better choice. This is because it can save wireless network bandwidth by avoiding large data transmission across networks, especially when mobile users are separated from the server by multiple networks. However, mobile devices are resource constrained and therefore, have difficulty satisfying a user's expectations when require large amounts of CPU time or memory [18]. That is why a web server might need two versions of the same web page, a normal page with full graphics for desktop computers and a mobile page for PDAs and smart phones, as well as a way to distinguish between desktop and mobile requests.

Developing web-based applications for mobile devices is challenging as there are a number of competing standards for application development on various devices. The *Wireless Application Protocol (WAP)* is a set of network protocols designed to enable different kinds of wireless devices to access web pages on the internet. The central part of the WAP architecture is a WAP gateway server that sits between the mobile device and the internet. The gateway server is responsible for translating information

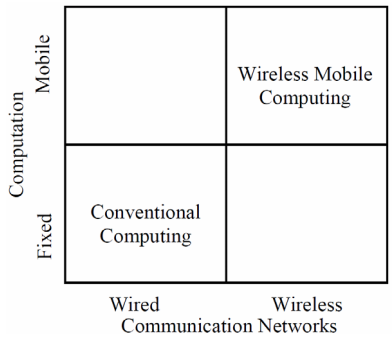

Figure 1. The wireless mobile environment.

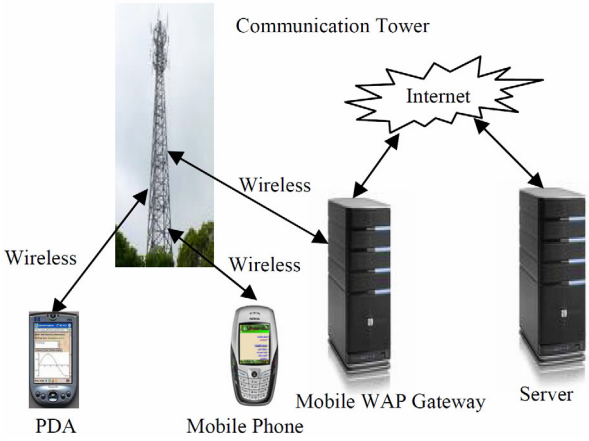

Figure 2. Internet-based mobile technology architecture.

requests from the mobile device into an HTTP request that the web server can understand. The server also checks the WAP compatible file from the web server to insure it is correct for the mobile device before forwarding it. Another important issue is that software applications have to adapt to match the requirements of the device based on its capability. Applications must deal with the technological challenges that are common on most mobile devices such as small display screens, reduced bandwidth, limited input capabilities, and restricted memory. Recently, the application of *offloading* mechanisms in the domain of resource constrained mobile internet computing start attracting the attention of many researchers [2]. In [18], the authors considered the offloading mechanism in mobile devices as a form of task distribution between the server and the client, which is in our case the mobile device.

The future trend in electronic commerce is *Mobile commerce (m-commerce)*, which includes any business activity conducted over a wireless telecommunication network. This includes B2C and B2B commercial transactions, as well as the transfer of information and services via wireless mobile devices. M-commerce is a natural extension of e-commerce and it is the base of a new generation of web-based electronic commerce. Mobile devices create an opportunity to deliver new services to existing customers and to attract new customers. However, the small screen size and limited bandwidth of most computing devices have limited consumer interest. So, even though the mobile computing industry recognizes the potential for B2C in m-commerce applications, the number of existing applications is quite small and uptake has been minimal. A number of corporations are providing their customers with the option of paying their bills via a cell phone. HDFC Bank of India, for example, allows customers to pay their utility bills using SMS. An increasing number of online vendors allow customers to shop from cell phones and

PDAs. Customers can use their wireless devices to perform quick searches, compare prices, use shopping cart, order, and view the status of their order. In Germany, people can use cell phones to pay for taxi rides. In Hong Kong, people can purchase drinks from vending machines with their mobile phones. In New Zealand, cell phones can be used to pay for time in parking meters [2].

Fig. 3 shows the value-added attributes that are possible only in mobile environment applications. New set of m-commerce applications are booming using this new era of computing, where services are accessed from the internet via a mobile device. The major attributes are *ubiquity* which means being available anytime anywhere, *convenience* where it is very convenient for users to operate in the wireless computing environment, *interactivity* where services are immediate and highly interactive, *personalization* where services designed to meet the needs of an individual consumer as mobile devices are truly owned and operated by a single individual, and *localization* where knowing the place a user is physically in at any particular moment is key to offering relevant services that suit the user at the moment.

III. ANALYSIS AND DESIGN

The new demand for internet access via mobile technology is driving toward the development of new generation of web-based wireless applications. Mobile devices are becoming the basic tools for such new applications.

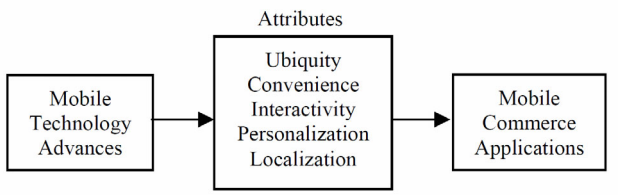

Figure 3. Value-added attributes in mobile environment applications.

Our system is a web-based wireless application that targets the tourism sector in Jordan to enhance and facilitate the tourism e-services. It provides the tourist with the flexibility to access the information needed about Jordan using his/her mobile device, anytime and anywhere. Now, we highlight the analysis and design models of the proposed system. But because of the limited space, we show just few sample graphs of the system models.

A. *Analysis*

The main functional requirements of the system are as follows:

1. Provide essential information about Jordan, like history, location…etc.
2. Provide information about major cities.
3. Provide information about places a user can go to or deal with.
4. Tourism information that includes:
   - Historical sites.
   - Natural sites.
   - Medical sites.
   - Religious sites.
5. Simple dictionary that contains most common tourism vocabulary.
6. Currencies operations that help the user to convert between JD and other major currencies.
7. Emergency telephone directory.

The system has several use cases that express its functionality for users as follows:

1- Ask for Tourism Services

- The use case begins when the user requests information about a service or a place.
- The user enters a key that satisfy his/her request.
- The system outputs the requested information to the user.

2- Translate Words

- The user requests translation.
- The system requests the word to be translated.
- The user enters a word.
- The system validates the word.
- The system outputs the meaning of the word.
- If the entered word doesn't exist, the system informs the user to re-enter the word or to add it to the dictionary.
- The user can update/delete any word from the dictionary.

3- Get Emergency Numbers

- The user enters a request.
- The system validates the request.
- The system outputs a telephone number that match the request.

4- Convert Currencies

- The user enters the amount to be converted, currency type, and targeted currency.
- The system converts currency based on the official rate.
- The system returns the equivalent amount.
- If the entered currency doesn't have a rate, the system informs the user to set the rate.

5- Add to Favorites

- The user requests to add an item to favorites.
- The system verifies the type of the item.
- The system adds it under the specified type.
- The user can delete one or all favorites from the database.
- The user views the items that can be added, before this use case begins.
- If the use case is successful, the favorite information is updated.

Fig. 4 depicts the relation between the use cases and the actor of the system. The use cases can be described as transition graphs, each stimulus sent between an actor and the system performs a state change in the system [19]. The actor represents any external entity that interacts with the system. In our case, the actor is the tourist or any other possible user.

Now, we focus on the most important models produced during the analysis phase, which is essential for the design of the system. Fig. 5 depicts the realization analysis models for the system. The use case realization analysis represents the understandability to the aim of the use case and describes how a specific use case realized and performed in terms of the interacting objects. Because of the limited space, we show only the figures related to the *Ask for Tourism Services* option as a sample. Fig 6 shows the collaboration diagram for the *Ask for Tourism Services* use case, which explains how the focus move from one object to another is performed and the messages that are communicated between the objects [20]. The analysis classes of the *Ask for Tourism Services* are shown in Fig. 7.

B. Design

Next, we refine further the actual implementation environment by explicitly defining the interface of the objects as well as the semantics of the operations required. We first translate the objects in the analysis model into design blocks, then describe how objects are interacting within each use case. Note that system blocks will make up the actual structure of the design model and show how the system is designed. These blocks will later be implemented in the source code. These blocks will abstract the actual implementation. The implementation of the blocks may be one specific class or more in the source code. Each analysis object will become a block in the design model. Objects obtained during the analysis phase are realized and converted to classes in the design phase. Because of the limited space, we show only the figures related to the *Ask for Tourism Service*s option as a sample. Fig. 8 depicts the design classes for the *Ask for Tourism Services* option. The class diagram shows more detail information that is needed for the adoption of the analysis model to the implementation environment, as illustrated in Fig. 9. The sequence diagram is shown in Fig. 10, which describes how the focus starting at the upper left corner moves from one object to another as the use case is performed and how messages are sent between objects.

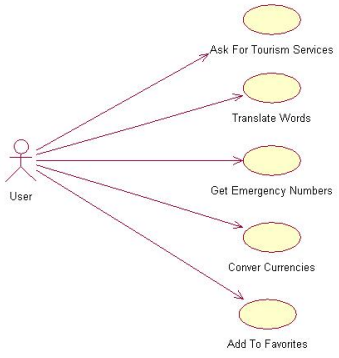

Figure 4. Use cases diagram of the system.

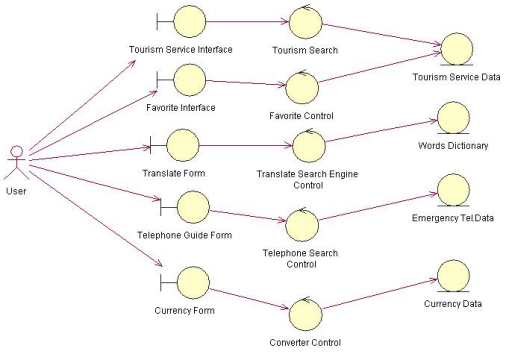

Figure 5. Realization analysis models for the system.

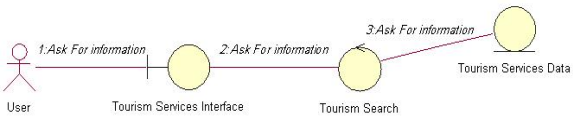

Figure 6. Collaboration diagram for *Ask for Tourism Services*.

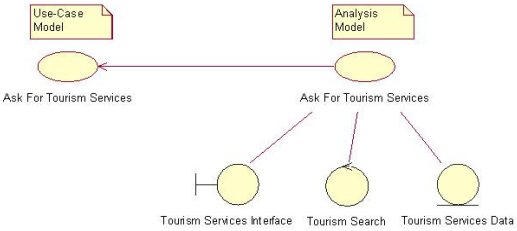

Figure 7. The analysis classes of the *Ask for Tourism Services*.

IV. IMPLEMENTATION AND TESTING

A. Implementation

The core of the system is implemented in a client/server based architecture using C#.NET and ASP.NET integrated with SQL server based on XML technology. C# is a simple object-oriented language derived from C++, Java, and Visual Basic. It aims to combine the high productivity of Visual Basic and the raw power of C++. It provides an easy access to the Microsoft .NET platform, which includes a common execution engine with rich class libraries [21]. Today's applications often require much more functionality than web browsing. It is for these applications that we look to the smart client model. The system

will run on smart devices like the Pocket PC 2000 and windows CE.NET operating system. This operating system is targeted for mobile devices such as PDAs and Pocket PCs that have small display areas, small storage areas, and run on batteries. The system requires a simple database for sorting and retrieving necessary data, the detail of this database is omitted from the paper because of the limited space.

The client part of the system is downloaded from the website to the mobile device with minimum functions that suit the minimum capabilities of the smart device. The user can access the system through his/her smart device which consists of the following main options:

- Tourism Service Interface.
- Currency Conversion.
- Telephone Directory.
- Dictionary.
- Favorites.

Fig. 11 shows the mobile device (client) side GUI of the system, Figs. a-c show sample information forms, while Fig. d shows the dictionary form as an example of service forms. As shown in the figure, for example when selecting historical sites from the information form, a map of Jordan appears that contain the most common historical sites. Finally, the user can pick one of the sites to get detail information about it, as shown in Fig. 11-c, where the user picked Petra.

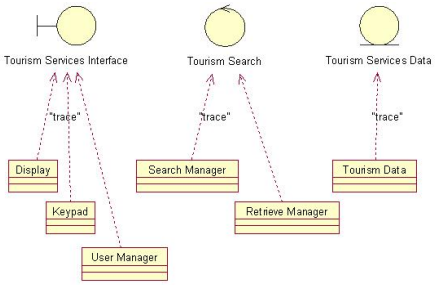

Figure 8. Design classes of Ask for Tourism Services.

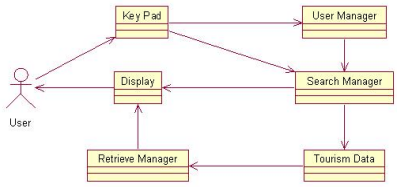

Figure 9. Class diagram of Ask for Tourism Services.

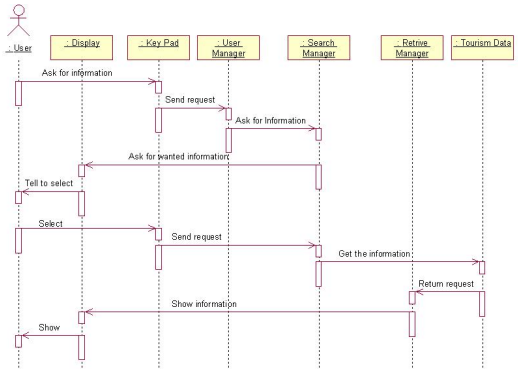

Figure 10. Sequence diagram of Ask for Tourism Services.

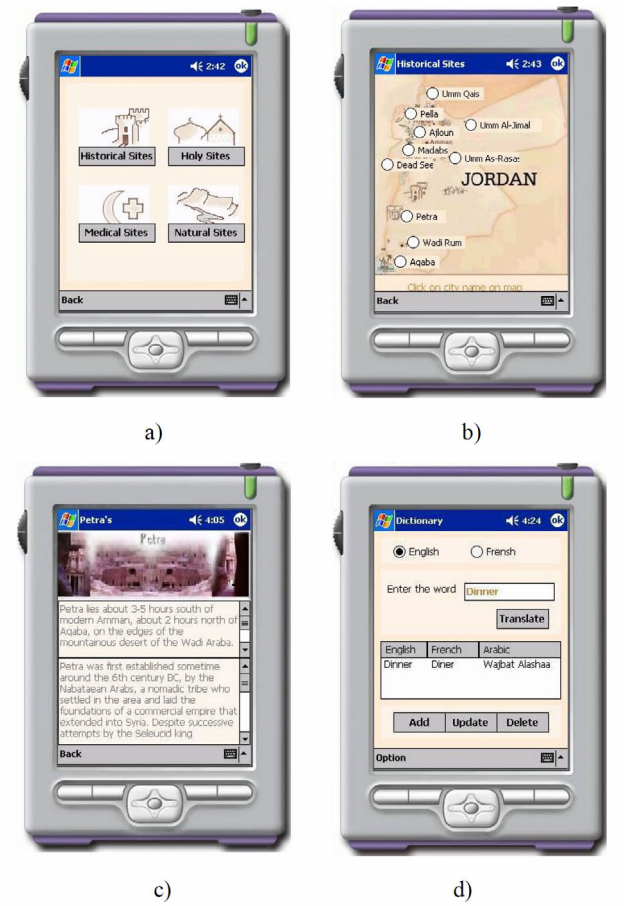

Figure 11. Client application.

B. *Testing*

Testing is an activity that aims to verify the correctness of the system that we are building. The testing model includes two activities:

- Verification: checks if we are building the system correctly.
- Validation: checks if we are building the correct system.

During the test model, we verify that the system correctly implements its specification. We develop a test model that consists of test cases. The test cases is a set of test inputs, execution conditions, and expected results developed for a particular objective, such as to exercise a particular path through a use case or to verify compliance with a specific requirement. We formally describe how to test that the use cases are implemented correctly. Fig. 12 shows a test case in the test model, specifying how to test the use case *Add to Favorites* in the use case model. The following shows the detail of the input, result, and conditions of the *Add to Favorites* test model:

1- Input

- The user requests to add an item to favorite.
- The system verifies the type of the item.
- The system checks if it is a duplicate item.
- The system puts it under a specific type.

2- Result

- The favorites are updated.
- The user can browse his/her favorites.

3- Conditions

- No other use cases are allowed to access the data during this test case.

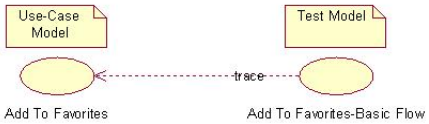

Figure 12. Test model for *Add to Favorites*.

V. CONCLUSIONS

This paper presents the design of an integrated mobile e-guide system for tourism using offloading service that can be utilized by resource-constrained mobile devices to run heavier mobile applications while enjoying mobility. The application can be downloaded from the internet to the mobile device, which enables the user to work offline without a mobile connection. The system architecture and the main components of the proposed service were presented and discussed. The system has been prototyped and validated in a real-time mobile internet application scenario. The system also has been evaluated through simulations in mobile network environment. Both experimental and simulation results demonstrated the effectiveness and efficiency of the proposed system. Future work will be to extend the system exploring more new offloading techniques that suit m-commerce applications.

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