Location-Aware Web Services

Introduction
Retail stores, shopping malls, museums, amusement parks, etc., are places where people search, seek related information, and eventually pay for products and services. Such physical places have been to a large extent abstracted on the Internet (e.g., WebVan.com, Metmuseum.org, Disneyland.com, etc.). Adding to the fact that virtual places are accessible from anywhere a computer and Internet access are available, other factors that make them interesting include searching capabilities and the use of user-specific information.

The focus of a UC MICRO-funded project entitled “Enabling Technologies for Location-Aware Information Exchange in Interactive Ubiquitous Environments” is to combine the benefits of the Internet with the intrinsic worth of the physical world. In this context, a user equipped with a roaming device will be able to obtain on-demand user and location specific product browsing capabilities. That project attempts to find a way to overlay a physical place (e.g., Albertsons) with its corresponding virtual place (e.g., Albertsons.com), in order to bring added value to the visitors’ experience. For this, the attractive features of virtual places will be extended to include features of the physical world, such as:

- **Searching capabilities.** This feature will apply to roaming users, as they can do advanced searches on the particular item they are looking for or on the items co-located in the physical place where the users are. They are also able to easily compare prices of the search results and select the cheapest one and locate it.

- **User specific information.** Users will login using their username and password to be able to use the system. e.g. a grocery store. Thus, they can keep track of what they have purchased in their previous visits. This can be extended such that, if they pass by an item that they have been purchasing regularly in their previous visits, the user interface of their roaming device will remind them of that. This feature can also be used in amusement parks where visitors can play location-dependant multi-user games.

The UC MICRO-funded project involves two major components:

1. An extension to existing session-oriented Web protocols to incorporate a location identifier in addition to the user-id, to enable user and location specific content delivery.

2. A cheap and easily deployable in-door location system that can be well integrated with existing roaming devices.

The focus of my project is to implement the first of the two components, assuming a locating system exists. We call it “location-aware web services.” In particular, the goal of my project is to come up with the necessary infrastructure for communication between the end-user’s roaming device and the web server that enables location information to be shared between the two. This way the users will know where they are in the contained physical space (e.g., grocery store) and will be able to locate items that they are looking for, either through a map that is shown on the roaming device or through a reference point to the item’s location (e.g., Aisle 2). This will require a revision in the way the traditional client/web server protocols function. In particular, it will require a set of rules to be set between the web server and the roaming device that will support location information to be exchanged.
alongside with other data and be perceived accordingly by both the web server and the client. Also some modifications are to be done to the roaming device's user interface.

The second component of the UC MICRO-funded project, the location system, is out of the scope of this project and will be done by the researchers in charge of the UC MICRO project.

**Project Components**

There are three major components to the location-aware web services:

1. **Web server.**
   The architecture of the web server is illustrated in Figure 1. The web server provides content (i.e. an html page) that contains information related to the physical world (e.g.: item description, price, item’s location, etc). For the purpose of this system, only the roaming devices that are held by visitors will access it. This will be done though a wireless local area network connection. The difference between a traditional web server and the one we will use for this project is that ours will have location information for the physical components in the real world (e.g., items in a grocery store).

2. **Location-aware client/web server protocol.**
   In order for the browser to be able to send location-specific data to the web server, a location-aware client/web server protocol must be implemented. Existing internet Web services can dynamically generate user-specific pages through the use of session ID tags added to URLs sent to the web server. We plan to use the same approach in order to incorporate the location information. As such, location tags will be added to URLs. That way, when a request is sent from the roaming device, not only the user ID will be passed to the web server, but also the location of user at the time of request will be presented. This way the web server can generate user and location specific pages to be viewed by the user on the roaming device.
Another issue is to devise a way of getting the roaming device’s current location from the locating system, to be passed to the web server through the location-aware client/web server protocol we just discussed. One way of doing this would be to implement our own browser that not only communicates with the web server, but also communicates with the locating system, retrieving the user’s location whenever necessary. A simpler approach is to implement a plug-in for a regular browser (e.g. Internet Explorer) whose task is to retrieve the location information from the locating system, and pass it to the web server through the location-aware client/web server protocol.

Roaming device interface:
For prototyping purposes, a PDA will be used as the roaming device. Through the locating system, the roaming device will know its location\(^1\) at discrete points in time.

The user will be able to browse, search, locate items, and view user-specific and location-specific pages through the roaming device’s user interface. (See Figure 2).

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\(^1\) Here, a location may be a geometric coordinate, a particular aisle in the physical space, or any other such reference points.
Role and Contribution to the Project

My role will be to design and implement the web server architecture including the location-aware client/web server protocol, the needed databases, and the dynamic page generator. I will also design the roaming device’s user interface.

For the purpose of this project, I will implement an online shopping environment without the shopping cart and checkout features, since shoppers will use this interface inside of an actual store (i.e.: a grocery store). Users are required to be registered and have to login in order to use the application. Once logged in, the users can do the following:

- Search for an item
- View all items in co-located in the aisle
- View detailed description of an item
- Look up their past purchases
- Update their profile
- View the items and/or special offers that are physically located around them. Since the locating system is not implemented yet, for this feature we will randomly pick a location for the user (i.e.: aisle 2, bakery…) and show the items and/or promotions that are located in that section.

The basic needs for this section of the project are:

- Software Components:
- Web server: Apache 1.3
- Database server: MySQL 4.0
- Scripting language: Perl 5.8 (server side)
- Programming language: Java and C++ (client side browser plug-in)

- Hardware Components:
  - Pocket PC with integrated WLAN 802.11b as the roaming device (needed)
  - A desktop computer as the web server (already available)

**Budget:**

1) **HP iPAQ Pocket PC h5550** $650
2) **.NET Wireless Programming book** $35
3) **Programming MS Windows CE .NET** $42
4) **Wireless Java: Developing with J2ME** $25
5) **Copying/Printing** $50
6) **Board (for UROP Symposium)** $50
7) **Poster printing (for UROP Symposium)** $100

**Total:** $952