LiNS: A Library Navigation System Using Sensors and Smartphones

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Abstract—This paper presents a library navigation system named LiNS, using a combination of Web, sensor and smartphone technologies. In addition to the function of an ordinary book search system, LiNS provides a library user with the function of finding the route from the current location point in the library to the point where the object the user needs is located. Furthermore, it offers the “See Also” function by which the user can get related and recommended information that may develop a user’s new interest.

Keywords-sensor; smartphone; sensor application; Web; library navigation

I. INTRODUCTION

These days, the ubiquitous computing technologies and mobile computing technologies are well advanced. These technologies enable us to develop several advanced applications and services that are helpful in our daily life activities such as health care, exhibition navigation, banking, entertainment, child watch and so on.

In the development of these kinds of applications, sensors play an important role. They can collect context information which consists of object location (person, book, etc.), room temperature, humidity, vital data, etc. There is much work in which context information is used. Smart Hospital [1] and U-HealthCare [2] use context information to provide health care services. Aware Home [3] produces an environment that is capable of collecting information about itself and activities of its inhabitants. In [4], context information is used to build a watch system for elderly people. Middleware for context-awareness have been also developed, e.g. [5], [6].

On the other hand, smartphones are becoming more popular these days, which are mobile phones offering PC-like computing capabilities. They can be used to develop various applications such as GPS, entertainment and Web applications.

In this paper, we present a system named LiNS (Library Navigation System), which combines sensors, smartphones and a Web server. LiNS allows library users to find the route from the current location point in the library to the point where the object (book, newspaper, magazine, etc.) they need is located. In ordinary libraries, users can get information such as the place of the book they are looking for, by using a “book search system” provided by a PC located at a fixed place. However, they might lose their way to the place if the library is large or complex, or they may forget the place on the way. LiNS can solve this problem by combining a book search system with smartphones and location sensors. Moreover the user can obtain suitable information in real-time.

In LiNS, each user has a smartphone and a sensor tag. They can know the place where they are going to and the route from the current place to the destination place, by seeing the geographical map on the smartphone. Consequently, it offers the user a more convenient library environment than the traditional book search system.

Besides, LiNS is based on the notion of “See Also.” For example, if the user is in the library, LiNS offers related and recommended information such as book ranking, recommended books and the bookshelf near the user, while walking around the library. This notion can contribute to developing their new interest in various things in the library.

The rest of the paper is organized as follows. Section II gives an overview of the LiNS system followed by its design in Section III. A prototype implementation of LiNS is described in Section IV. Finally, Section V concludes the paper.

II. OVERVIEW

In addition to the function of an ordinary book search system with which users can know what kind of objects are in the library and where the objects are, LiNS can offer them various functions obtained by combining the function with their context information such as their current locations and profiles.

Fig.1 shows an outline of the structure of LiNS which consists of three general components: a control server, sensors and a smartphone. The control server controls the whole system, and comprises three software modules, i.e. control module, sensor module and library information module. In particular, it integrates the library information and the user context information. The sensors are used to detect the user’s current location in the library. The user has a sensor tag, and it is detected by the location sensors installed in the library. The user accesses to LiNS using the smartphone, and through its graphical user interface he/she can get various information which include information of the object he/she needs, related information with the object, the place of the object in the library, the route to the target.
A typical processing flow of LiNS is as follows: 1) The sensor tag which the user has is detected by a location sensor; 2) The location sensor sends the location information to the sensor module; After that, 3) the sensor module passes the location information to the control module; 4) The control module picks up information from the database according to the location information; 5) When the user via the smartphone accesses to the control server through the wireless network, the control module provides the user with several services which are provided by combining information from the database, information from the library information module and the location information.

The following are typical information which LiNS offers:

- If the user does not have clear purpose, LiNS provides recommended information of the library. They are provided according to the context such as the user profile (e.g. age, sex, career, etc.), the user's current location and the environment (e.g. present season). For example, information for magazines for young girls in the bookshelf near the user might be recommended if the user is a 16-years old girl.
- If the user has clear purpose, LiNS provides the object information of the object the user needs and its related information. Examples of these information include the title, author and category of a book, this week’s rank of the book, the bookshelf where the book is located and so on.

The provision of recommended information is a main advantage of LiNS that is obtained by integrating the library information with the context information.

The other information and services provided by LiNS are given in the next section.

III. DESIGN

In this section, we describe the functions, services and system components of LiNS.

A. Functions and services

LiNS provides the user with the following functions and services:

- Object search:
  The user can know what kind of objects are in the library and where the object (e.g. a book, a magazine, etc.) he/she is looking for is located in the library.
- Indication of user’s current location:
  The user can know where he/she is in the library.
- Indication of route to the object:
  The user can know the route from the current place to the destination place where the object he/she needs is located.
- Library layout indication:
  The layout (map) of the library is geographically displayed on the smartphone.
- Retrieval of object information:
  The user can get information such as the title of a book and the publication date of a book.
- Retrieval of related information:
  Information related with the object the user needs can be obtained.
- Indication of recommended information:
  Information which seems suitable for the user is indicated automatically or as he/she demands. The contents of the indicated information depend on the context such as the user’s profile and the current location.
- Learning of user location:
LiNS should recognize the user’s current location as exact as possible. Therefore, LiNS learns automatically the location by letting him/her tell the location if he/she knows exactly where he/she is.

B. System components

As shown in Fig.1, LiNS consists of the three system components, and each component is organized by the software modules shown in Fig.2. In this subsection, we describe these components and software modules.

(1) Sensors

The main behavior of a location sensor is to detect the user’s location by identifying the tag which the user has and to send location information and own MAC address to the sensor module. To detect the user’s location, we employ Receive Signal Strength (RSS) measurement method. By calibrating RSS, the sensor can cover from a narrow area to a broad area. We use two kinds of sensors: narrow area sensor and broad area sensor.

A broad area sensor covers the whole library and it is put near to the control server. The broad area sensor recognizes whether the user is in the library or not.

On the other hand, a narrow area sensor covers part of the library and it is put on a shelf in the library. It detects a fine user’s location.

These sensors send location information to the control server periodically.

(2) Smartphone

The smartphone is used as an interface between the user and LiNS. We suppose that the user beforehand downloads the LiNS application which was developed for the smartphone.

The main behavior of the smartphone is to pass various user requests for library navigation to the control server. The smartphone narrows down the information sent from the control server in response to the user requests, and shows the necessary information for the user. The following information is output to the user through the screen of the smartphone:

- User’s current location.
- The place where the object is and a good route to find the object which he/she wants.
- Object information (e.g., book name, author, date of publication, publisher, category, etc.).
- Related information (e.g., popularity rank in the same publisher).
- Recommended information (e.g., information for magazines in the bookshelf near the user’s current location).
- Geographical map of the library.

To know the user’s location accurately, the system asks to input his/her current location and register it. By doing this, we can expect an accuracy enhancement of gaining the current location.

(3) Control server

The control server is the core of LiNS. It integrates the library information (e.g., book, bookshelf) and the user context information (e.g., current location, profile).

The control module controls the whole system, and it mainly performs the following processing:

- Understanding of user requests and the corresponding processing. This includes mediation between the library information module and the smartphone.
• Association of library information with location information.
• Management of location information.
• Retrieval of information from DB and derivation of recommended information. The information from DB includes a user profile (the user’s personal information, his/her history of object search, etc.), the user’s location, the present season and so on. They are used to derive the recommended information suitable for the user.

The library information module looks like an ordinary book search system. It searches for object information by using DB, e.g. information of books which have keywords specified from the user. It also searches for related information, e.g. the rank of the book and the bookshelf where the book is located.

The sensor module collects location information from the location sensors, and sends them to the control module.

IV. PROTOTYPE IMPLEMENTATION

We are now implementing a prototype of LiNS in a room of the library of our college. In this prototype, we are using SunSPOT provided by Sun Microsystems, Inc. as a sensor, and iPhone provided by Apple, Inc. as a smartphone. In this section, we show part of the implementation.

The layout of sensors is shown in Fig.3. Narrow area sensors are located on the shelves for general books and the shelves for new books. To detect the user’s current location, they are also located in the multipurpose space and by the entrance. To cover the whole area of the room, a broad area sensor is deployed near the control server. We are developing a dedicated objective-C application for iPhone and Java application for SunSPOT. PHP is used for software development for the control server.
We have been implementing a prototype of LiNS. There are some issues in this prototype. At first, the response of the system to one user has been tested but not to multiple users, so that an appropriate behavior for multiple users may not be guaranteed. The treatment of recommended information provided from LiNS has not been implemented yet. It is still open how to make such information from library objects information and user’s context information. We will upgrade the prototype by solving these issues.

As a future work, we should go through many implementation tests, and find critical problem of LiNS. In addition, we will bring in more context-aware information in our system. In this way, we expect that users can have a more good time in a library. We hope that LiNS will contribute to more activation of resources in a library and such an institution.

REFERENCES


