Ambient Browser: Mobile Mixed Reality System Based on Ambient Intelligence

Dea-Gyun Kim, Yong-Hee Jang, and Yong-Jin Kwon

***Abstract*—Although hardware and technologies for mobile devices have evolved, searching for information an outdoor environment requires a significant amount of effort given the time consuming manipulations that need to be made. In this paper, we present Ambient Browser, digital map-based mobile Mixed Reality (MR) system that adopts a concept of Ambient Intelligence. The general purpose of the system is reducing the user's efforts and providing information that is considered by user's context. The system integrates real-time sensing technologies (GPS and other embedded sensors) and exploits user's context (location, preference and etc.) in order to provide him the necessary information about real-word geospatial objects. The necessary information on mobile devices is powered by Mixed Reality. We also describe a scenario in which the user is traveling by using the system and show a practical example using the system we have developed.**

***Index Terms*—Location-based services, mixed-reality, ambient intelligence, mobile devices.**

I. Introduction

Service environment for information retrieval are expanded beyond the indoor to the outdoor along with the promotion of positioning measurement technology and the development of wireless networks such as 3G and 4G. However, for acquiring some information using mobile devices in outdoor environment, the users have to make use of the existing search method such as keyword- based search as ever. The Keyword-based search is very inconvenient on mobile devices because of the size of the keyboard and the display is very small. Thus, location-based information services are introduced and expanded recently as a way of overcoming these problems. However, the services only applying of GPS coordinates for the positioning usually fail to provide appropriate information since the coordinates are not accurate. Consequently, additional works such as inputting some queries are demanded in order to obtain the appropriate information. Therefore, for addressing these problems, we propose a searching system that enables users to acquire the information immediately without the additional works on mobile devices in this paper.

The system, named as Ambient Browser, provides user's necessary information without the additional works, only just focusing on an object about which users want to know with the built-in camera on mobile devices so that the related queries are generated automatically. In addition, the system has an advantage that provides virtual information and sees real space for user to associate with the information and the real space on a screen of mobile devices through augmented reality technique [1], [2], [6]. The system identifies a location of user and a direction of user through GPS sensor and Digital Compass sensor on mobile devices [3], [4], [5]. Then the system generates search area corresponding to the position and the direction in structured spatial information space with digital map that store a location and a size of the object. Subsequently, the system determines the object in the generated search area through estimating a visibility of the spatial information with a formula.

The information that indexed each object contain not only their own information such as a name of the object and a name of shops in object but also utilization information that a role of object such as information of remaining seats in library and information of menus in restaurant. Consequently, this system allow the user to acquire the information instinctively through displaying the search result with own information and utilization information formed by text, image, or video on the screen of mobile devices.

The paper is organized as follows. In Section 2, we describe the Ambient Browser system, with a scenario, architecture and sequence of interaction with the system. Section 3 concludes our present study and addresses future works.

II. Ambient Browser

A. Scenario

A Korean man visits an airport of France for travel at first. When he arrives the airport, since he doesn't know the French language and inside of complex the airport, it is hard to that he goes to a hotel by a bus. Then he looks at the inside of the airport through camera on a mobile device, and he goes to the bus stop easily through an arrow and an explanation of navigational information in Korean on the mobile device. And when he arrives the bus stop, he can shows the explanation of bus for the hotel, so that he can goes to the hotel easily too.

The next day, he leaves the hotel and goes to the suburbs to see ancient buildings. He wants to know about information of an obelisk such as name and history, when he finds the obelisk while looking around the suburbs. In general, people are provided the information of obelisk through keyword search where keyword is obtained by searching a map or map services of web. However, he is provided the information of obelisk through just action of focusing on the obelisk with the camera on the mobile device.

Then he goes to the town to eat a lunch. He can see a many

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restaurants, but he doesn't know about the information of restaurants such as menus of restaurants, the price of menus, and whether menu is delicious. Generally when people want to know information of restaurant, they use keyword search through name of restaurant, then the obtained search results are difficult for them to know what they really want to know thus they have to sort the search results. However, the Korean tourist is provided not only information of restaurant but also related information such as recommended menus or evaluating of menus.

When he finished his lunch, he goes back to the hotel and considers about the next day's schedule. Generally, people acquire a location wishing to travel through a travel guide book or map, and related information of museum and the remains through the travel guide book or the Web. For the acquiring the information in the Web, user has to check a results of keyword search for surrounding information based on the location one by one. However, he previews information of surrounding information based on a virtual location wishing to travel immediately by clicking the location in the map and viewing surrounding objects on the mobile device as if he is in virtual location.

Let's assume that sensors can obtain information of context such as user's location and surrounding information of the location, and space that is stored travel information associated the user's location on the real space exist. Moreover, assume that users have mobile device with camera and express their interest through the camera. If a system can recognize context of user through GPS sensor and image of camera, user can search travel information wishing to travel while go about a city without preparations by using mobile device that access the Web. Travelers can acquire information of object that they want to know on the move immediately.

In addition, user is provided a map information and related information of user's location through mobile device with GPS sensor. Consequently, user can search interest information of user's surrounding in travel freely without any preparation[6].

B. System Architecture

In this study, Ambient Browser for Ambient service is to provide information of an object through recognition of objects in area that user focused by using camera, basing on the digital map that express a real space and user's context.

The system consists of many components as shown in the Fig. 1.

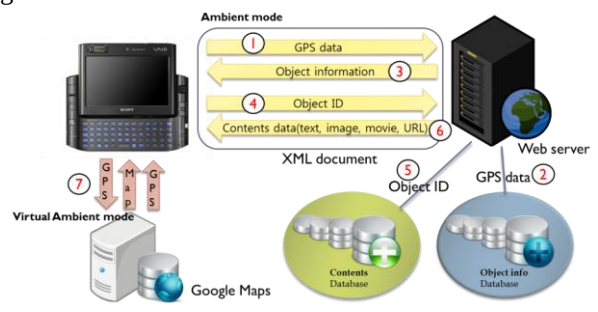

Fig. 1. Ambient Browser system architecture and flows.

Mobile Device (Client): Mobile device for providing a user with spatial information has many sensors such as GPS and digital compass for acquiring user's context and expresses search request of users through an action of users by using camera on the mobile device.

Web-Server: When Web-server receive a GPS coordinate of user from mobile device, send a Map DB of surrounding of the location, and when the server receive an object's ID, send a multimedia information of tagged Content DB.

Database: Database consists of index of R*-Tree, Map DB that manages original geo-spatial data and tagged Content DB that stores virtual information based on a location.

Map-Server: Map-server provides user with map information for GPS coordinate, when the user wants to know about information of virtual location.

User has mobile devices that equip many sensors for obtaining the user's context data. User expresses a search request through looking at a real space by using mobile device. Built in sensors gather data that are used for object recognition and information for recognition of context of user or mobile device. Built in sensor are GPS, digital compass and gyro sensor. Data extract program is implemented with Visual C++ and added in Ambient Browser.

Databases are used in this paper are separated two types. One is spatial index DB to manage large spatial data efficiently by using a spatial search algorithm. Other is contents DB store tagged virtual information based on a position. Spatial index DB is consist of R*-Tree based on MBR and R*-Tree based on Rotated-MBR. This DB is structure that possible to fast search for spatial query. Contents DB store POI (Point of Interest) data and position data of interest area. Geo-spatial data is file DB and store Bitmap data for fast Drawing.

Web-Server provides user with information of multimedia and related information from Contents DB that are tagged based on location when user requests information. Users can acquire multimedia information of real space in real-time by using a mobile device. For example, when user takes a picture near a building by using a mobile device, the mobile device automatically searches the building's name and location, and sends the picture to Web-Server to store in Contents DB with the location and the building name without any additional works. These works that manage a user's requests of search and store are Web-Server's works.

C. Real-Time Spatial Object Recognition Algorithm

An important algorithm of Ambient Browser is recognizing a spatial object of an image based on digital map search for user's needs that comes from image in camera. Steps of real-time spatial object recognition algorithm are focusing on search range by using camera on mobile device when user wants to search information of object, at the same time acquiring context information based on sensing information, and generate search area. The algorithm can recognize object through digital map and geometry algorithm, and provide user with location based web information for recognized spatial object from Geo-Server.

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A camera on mobile device is tool of expression that is user's needs of searching information where the camera provides user with virtual information and real space. In other words, this is a part of inputting a keyword in information search system based on keyword when user's needs are occurred. For example, user focuses on Namdaemun to acquire virtual information of Namdaemun by using camera. Consequently, user's needs for real space is expressed visually and spatially without keyword. This expression of information needs is better than information search system based on keyword because of reducing a user's effort to generate appropriate keyword for the needs, to input keyword and to select appropriate information among a search results. GPS, Gyro-sensor and digital compass is equipped in mobile devices to acquire a user's context. GPS provides location information of mobile devices or users, and Gyro-sensor provides information of angle how many lean with the horizon, and digital compass provides information of azimuth. The algorithm generates information needs range based on these information of sensors to recognize a spatial object.

When users want to search information of object in real space, context of users are acquired from just action that users focus on the object by using camera on the mobile devices with sensors. At this case, since the camera has angle of view and distance of view, we can generate search range that shape as triangle through using a digital map. The range of triangle generated is become search range to express the information needs of users.

Fig. 2 shows a process of generating search range and acquiring information of sensors by using mobile devices.

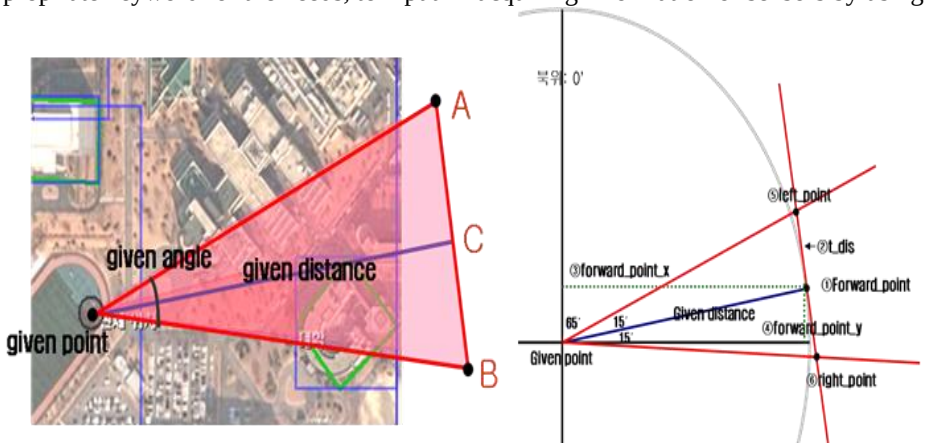

Fig. 2. A process of real-time spatial object recognition algorithm.

Through the algorithm and sensors, we can recognition the object that users want to know, so that Ambient Browser provides user with necessary information.

Fig. 3 is a representation of our system, where a user points his mobile device towards an object, Aerospace Museum in Korea Aerospace University. The user sees web page related to the museum with the real scene. Then he can interact with the object in order to get more information about the museum. This information filtered according to the user's context and displayed on the object using mixed reality.

He can also get the information using virtual ambient mode in the system. He controls his location on the map and rotates the mobile device, and then he can get information about an object that is pointed by camera's angle for the controlled location.

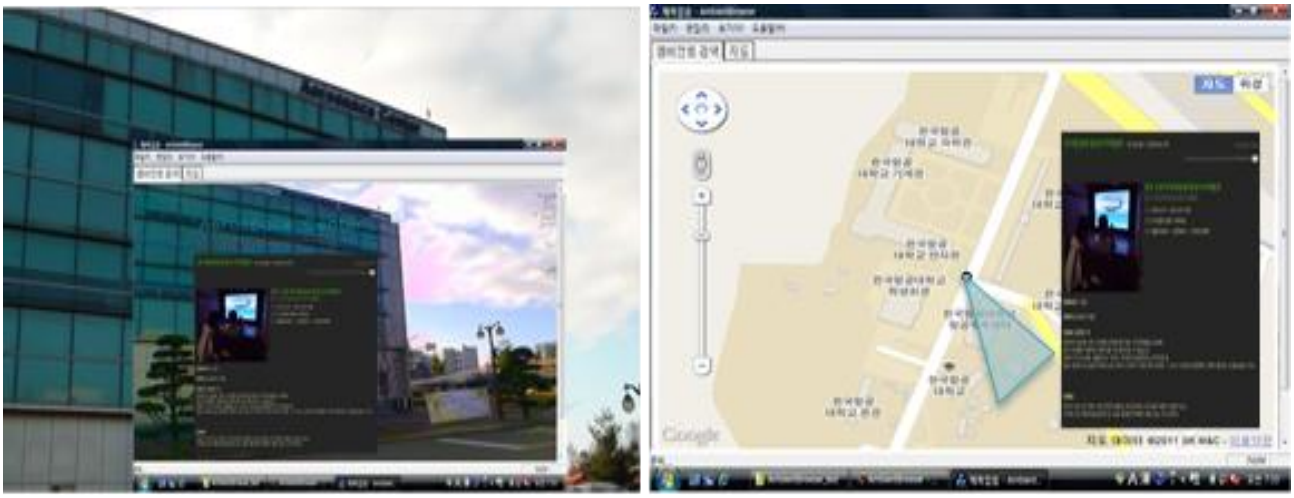

Fig. 3. A practical result of ambient browser.

III. Conclusion and Future work

In this work, we have described Ambient Browser, a mobile mixed reality system based on Ambient intelligence. We also described a scenario about using the system and provided a practical example showing an implemented the system. Through extracting spatial data of objects in a digital map and sensing, proposed system generates the query automatically, reduces the user's effort to search information and displays information intuitively using mixed reality.

These three features will contribute to the design a mobile location based systems that are focused on user's context with a digital map.

In our future work, we plan to construct the Contents database automatically by using GPS data from the digital map. We will obtain contents data corresponding with the location data to construct the database by using crawler.

Moreover, we will focus on analysing error of GPS and find the solution by using a simple image processing. In the downtown, GPS error is often occurred. Most location based systems do not work well because of the GPS error. To correct the GPS error, we will use a simple image processing such as contour extraction. Through comparing with digital map data and contour data, we can correct the error.

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