Process and Location-Aware Information Service System for the Disabled and the Elderly

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Abstract. This paper presents a context-aware information service system for people with disabilities and for older adults. The system guides users who have difficulties in performing complicated tasks or finding paths at public places such as hospitals or government offices. The system is composed of sensor networks and a local information system which work together to gather the location and the process information, a user device which directly provides guidance to the user, and an information service server which understands the user context and provides guide contents.

Keywords: context-awareness, context model, human-computer interaction, system framework, mobility.

1 Introduction

Many people have experienced getting lost in public places such as hospitals or government offices. People sometimes cannot find their destination or determine their direction due to the complex structure of the building – they are in, and unfamiliar and/or complicated procedures can make also cause people some difficulty. These difficulties are compounded for people with disabilities or for the elderly. For example, a directional sign can be helpful for people who have trouble with directions. To a visually impaired person, however, graphical information is useless. Moreover, a hearing impaired person who is not familiar with textual information can have problems reading a directory. Although there are often helpers or technical aids for the disabled in many public places, the amount of such help available is limited because of the high cost.

Although many context-aware systems have been developed to solve these types of problems, most systems developed thus far only provide fragmentary guidance while focusing on the location information or temporal conditions. In order to be more practical, it is necessary that the system gives general guidance about what to do, how to do it, and where to go. In addition, the guidance needs to be provided through a range of channels and formats based on a user model.

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This paper presents a context-aware information service system for the disabled and/or the elderly – that helps the user accomplish complicated procedures by providing relevant information through an adaptive interface.

2 Related Work

Paganelli et al. [3] applied an ontology-based model to the development of a context-aware eTourism application which provides tourists with context-aware services. Tourists receive information about services in a manner depending on the current situation. This information can be shared with other tourists and with tourist service providers as well.

Stephanidis et al. [5] introduced the PALIO (Personalized Access to Local Information and services for tourists) service framework. The system is capable of delivering fully adaptive information to a wide range of devices and can integrate a variety of pre-existing and forthcoming services. It also supports dynamic adaptation both in terms of the content and the presentation. For example, a tourist who is interested in sightseeing and prefers visiting monuments and museums may, with his mobile device, access the City Guide service and ask for recommendations about what to do next. The tourist could then obtain recommendations that include a wide range of activities.

Muñoz et al. [2] presented a context-aware messaging system that allows health care workers to exchange messages that depend, for their delivery, on the status of people, resources and/or devices. It is especially designed to support contextual elements that define information management and collaboration in hospital settings. For example, when a physician decides to send a message to the doctor who will be reviewing a patient on the afternoon shift, the physician turns to his PDA showing the Context-aware client, which lists the staff and devices available in the hospital, to send a message to the first doctor to check the patient during the next shift.

Mikael et al. [4] presented a context-awareness system for mobile electronic patient records through a prototype known as MobileWard. This system support nurses as they conduct their morning procedures in hospital wards. It can provide information and services to the user where the relevancy depends on the user's task – and it is able to discover and react to changes in the environment by sensing the physical location of the user.

3 Process and Location-Aware Information Service System

A location-based context-aware system is limited in terms of providing guidance for complex processes. On the other hand, a process- and location-aware information service system can understand the spatiotemporal context based on a knowledge model that represents the user’s process (time) and location (space). For instance, the system extracts a suitable process from the knowledge model based on the user’s goal, and, provides the user’s detailed task flow from the location of the user and the task log. Users can receive personalized guidance from the adaptive assistant user interface (AAUI) based on the user model (Figure 1).

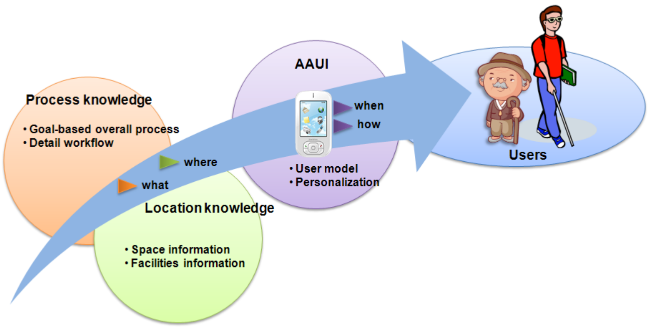

Fig. 1. Process and location-aware information service system

3.1 Overall Architecture

The process- and location-aware information service system includes the following components: a local information system, sensor networks, user devices and an information service server (ISS). The user device has a user interface manager and a communication manager, and the ISS consists of a task manager, a context manager, a knowledge manager that connects to a knowledge base, and a communication manager. The overall architecture is illustrated in Figure 2.

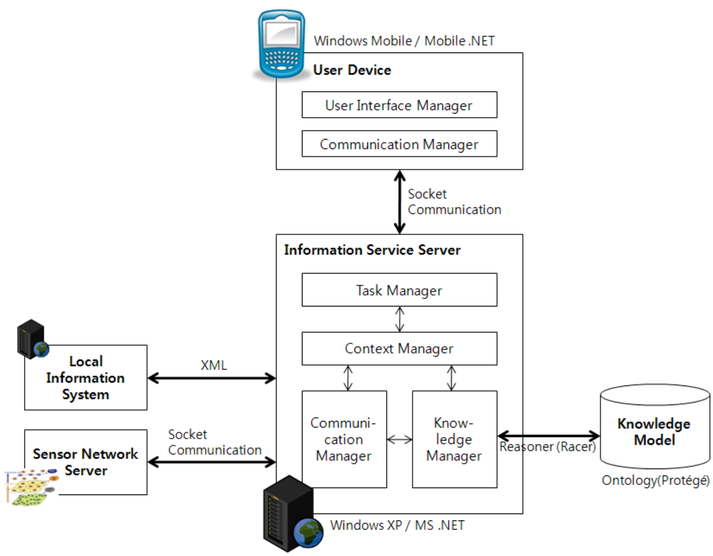

Fig. 2. The architecture of the process- and location-aware information service system

3.2 Local Information System and Sensor Network

Most agencies such as hospitals or government agencies have their own information system which helps people communicate, stores various contents such as maps, and manages business processes. The proposed system integrates this system into a local information system that provides spatial information such as a plot plan and user processes. This fundamental information is stored in the knowledge model and updated when there have been any changes regarding facilities or processes.

The local information system also handles all impending events when a user has executed tasks. For example, immediately after a patient receives a medical examination, the local information system of the hospital recognizes that the exam has been done and retrieves information from the doctor's input concerning the lab that the patient should visit.

A sensor network consists of sensors and middleware. Low-level data gathered from sensors are converted into useful location information from the middleware, and the middleware sends this information to the ISS.

The communication between systems or networks is accomplished via WLAN, the standardized communication channel. The local information system is loosely coupled with the ISS and exchanges XML documents, and the sensor network employs socket communication with the ISS.

3.3 Information Service Server (ISS)

The information service server plays a central role in the entire system. The information service server infers the user context with the location information from the sensor network, process information from the local information system, and sends guidance contents to the user device.

The reasoning steps of ISS are as follows: first, the overall process is set with the goal of the user. While the user is executing tasks, context information is gathered and the user context is set. If it is necessary to change the process, the ISS sets an alternative process. The system sends guidance to the user and it loops until the process is finished. Figure 3 shows a flowchart of the ISS.

The ISS has four managers with independent functionalities. The managers are the task manager, the context manager, the communication manager, and the knowledge manager. The context manager, which obtains information from the communication manager and the knowledge manager, directly infers the user context with the contextual information. The communication manager communicates with the sensor network and the local information system. The knowledge manager administers the knowledge base, and the task manager determines the contents to be provided.

3.4 User Device

The user device has two managers: a communication manager and a user interface manager. The communication manager takes charge of all communication through the user device. The user interface manager converts guidance contents based on the user model. For instance, text content is converted into aural content with TTS (Text-to-Speech) for a visually impaired person; small text is magnified for the elderly.

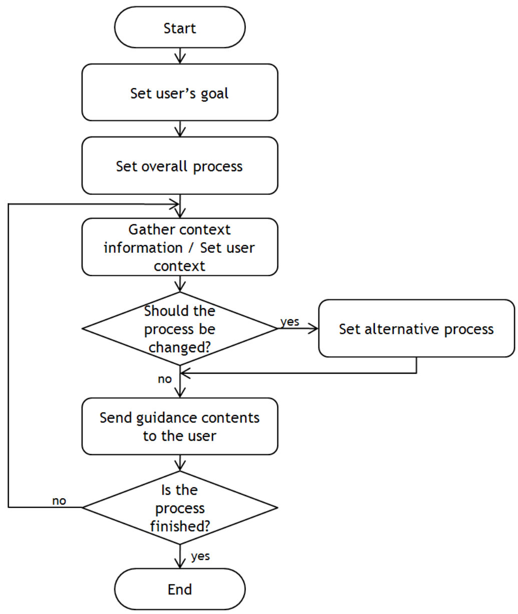

Fig. 3. Flowchart of the information service server

3.5 Contextual Elements and Knowledge Model

As most context-aware systems infer a user's current task only via the location of the user, occasionally these systems cannot provide accurate guidance or give fragmentary information. In order to recognize the user's situation clearly, as mentioned above, the proposed system gathers two user properties: the process and the location. For example, if a visitor who must wait after taking a number skips the procedure and simply sits in a chair, the system can help the user complete the incomplete task. Additionally, when a user who previously made a reservation on the phone is at the appointment, the system can guide the user to the task zone, for instance, to the clinic and not to the reception desk.

The knowledge model is designed to support the system. The knowledge model has three main parts: the process-context, the location-context and the user-context parts. A process is selected within the user's goal and defined as a flow of services; a service is related to the actual services of an agency and is defined as a flow of tasks. A task is defined as the standard unit that the user executes. Similar to the relationship of the classes of the process-context part, an area is defined as a group of zones; a zone is the standard unit covered by a sensor and in which a task is executed. The area and the zone are logical concepts and are connected to the physical structure, such as to the floor, room, hall, aisle, or some parts of the facility. A user, the user type, and the user's goal are also defined in the knowledge model. Figure 4 shows the structure of the knowledge model.

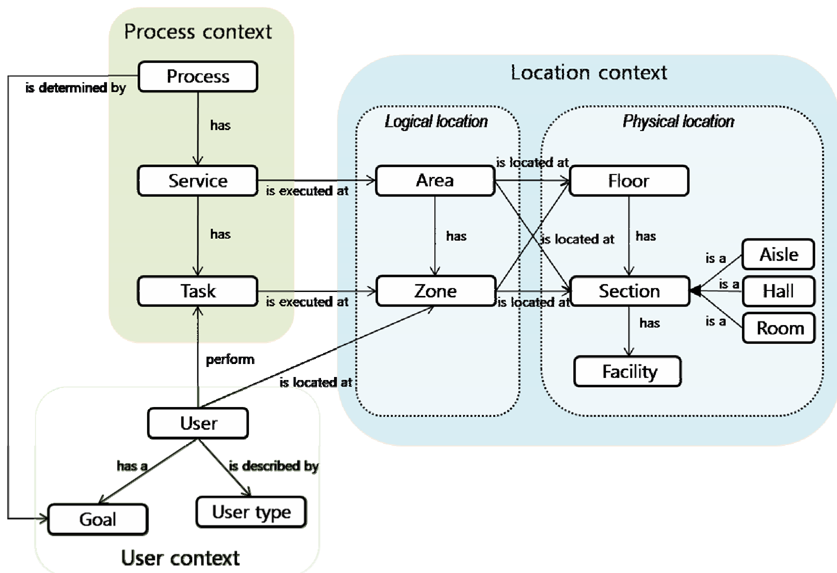

Fig. 4. The structure of the knowledge model [5]

4 Example Application: A Context-Aware Hospital Guide System

One of the advantages of the proposed system is its application potential to various agencies as well as the fact that is not limited to a certain domain. As an example application, the system was implemented in the domain of a hospital, which has complicated processes and complex structures. Although some hospital information systems which target hospital workers such as nurses have been researched [2][4], the proposed system in centered on the patient who receives the information. The example application, a context-aware hospital guide system, focuses on patient who may have disabilities; it provides guidance about what to do and where to go at the hospital.

The system was made to cover scenarios that may occur when the user has very recently received a medical examination at a clinic and is moving to a laboratory:

- (Scenario 1) The system initiates a messaging event in relation to the location: Directly after the patient leaves the clinic, the system provides route guidance.

- (Scenario 2) The user initiates a messaging event in relation to the location: While the patient is on the way to the laboratory, the patient requests his/her location.
- (Scenario 3) The user initiates a messaging event in relation to the process: The patient requests information about the tasks at the laboratory.
- (Scenario 4) The system initiates a messaging event in relation to the location: The system receives the patient's location and infers that the patient has just arrived at the laboratory. The system gathers data about number of people waiting and sends a message to the patient.

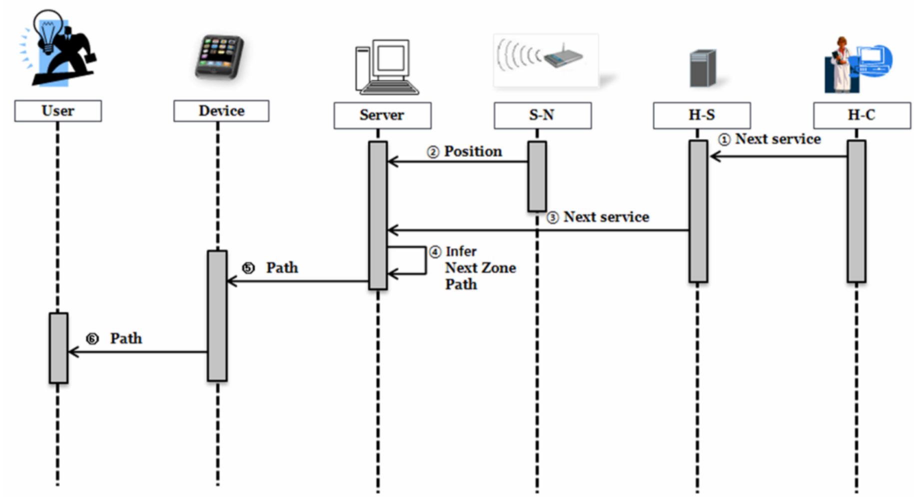

Fig. 5. Sequence diagram of Scenario 1

The scenarios are expressed using UML diagrams. Figure 5 shows a sequence diagram of Scenario 1. The ISS continuously receives the location information of the patient, and when a client of the hospital information system such as doctor (actor H-C) inputs the patient's next service into the hospital server (H-S), the ISS infers the next zone of the patient and sends messages to the patient.

Figure 6 shows the user device and implemented application. HP iPaq PDAs were chosen for the user device, and a CF-type portable 2.45GHz RFID reader (Synometrix SMPD-100[6]) with 10 meter read range was utilized for the sensor. The user device is connected to the ISS via WLAN. The user interface is designed to be as simple as possible, lest a user became confused. The user can switch between two screens, the first with the route guidance (and the name of the task that the user should complete) and the second with the detailed service/task information.

The user interface in Figure 6 is meant for the elderly; all possible guidance information is provided and the minimum size of the font is 16 in order to maximize its visibility. For a person who is visually impaired, the interface can be changed into an aural interface.

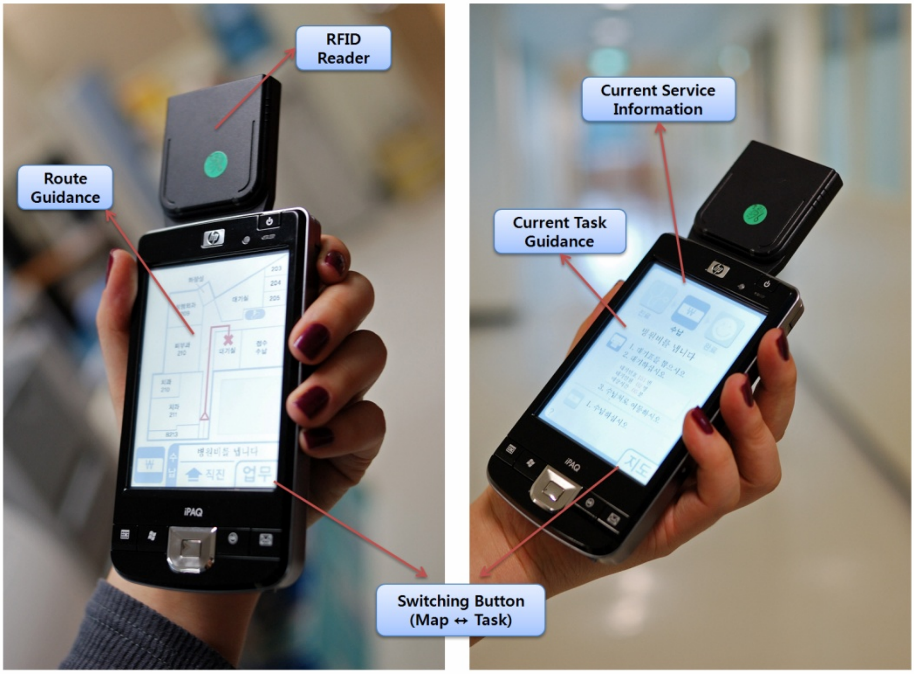

Fig. 6. Context-aware hospital guide system

5 Conclusion and Future Work

This study has described a process- and location-aware information service system for the disabled and for the elderly. This system provides a combination of process and location information with the spatiotemporal context of the user. The overall architecture of the system and the structure of the knowledge model are presented, and a context-aware hospital guide system is shown as an example application. The system is designed to be applied to any agency with a complex structure and complex processes. It can provide intelligent guidance compared to location-based service systems.

The example application was developed for a patient in a hospital domain. Due to integration difficulties, the test was accomplished at an office instead of at an actual hospital. In a future work, the system will be integrated with a hospital information system and sensor networks. Moreover, there will be efforts made to standardize the interfaces of the information systems for agencies to streamline application of the proposed system. Finally, a user test will be performed to verify the effectiveness of the system.

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References

1. Kim, G., Han, M., Park, J., Park, H., Park, S., Kim, L., Ha, S.: An OWL-based Knowledge Model for Combined-Process-and-Location Aware Service. In: 13th International Conference on Human-Computer. LNCS. Springer, Heidelberg (2009)
2. Muñoz, M.A., Gonzalez, V.M., Rodríguez, M., Favela, J.: Supporting Context-Aware Collaboration in a Hospital: An Ethnographic Informed Design. In: Favela, J., Decouchant, D. (eds.) CRIWG 2003. LNCS, vol. 2806, pp. 330–344. Springer, Heidelberg (2003)
3. Paganelli, F., Bianchi, G., Giuli, D.: A Context Model for Context-Aware System Design Towards the Ambient Intelligence Vision: Experiences in the eTourism Domain. In: Stephanidis, C., Pieper, M. (eds.) ERCIM Ws UI4ALL 2006. LNCS, vol. 4397, pp. 173–191. Springer, Heidelberg (2007)
4. Skov, M.B., Høegh, R.T.: Supporting information access in a hospital ward by a context-aware mobile electronic patient record. Personal and Ubiquitous Computing 10(4), 205–214 (2003)
5. Stephanidis, C., Paramythis, A., Zarikas, V., Savidis, A.: The PALIO framework for adaptive information services. In: Multiple User Interfaces: Cross-Platform Applications and Context-Aware Interfaces, pp. 69–92. John Wiley & Sons, Chichester (2004)
6. Synometrix, `http://www.synometrix.com/`