An Ambient, Personalised, and Context-Sensitive Information System for Mobile Users

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Abstract

In this demonstration, we will show a context-aware information system intended for mobile users. The demonstration involves special-purpose hardware devices, called 'context tags', which can work with mobile devices such as mobile phones, to provide ambient information to users on the move. Key to the framework is special support for content service providers, through software that allows existing content to be delivered seamlessly to mobile devices, as and when it is needed by users. The demonstration will show how these components work together to provide an effective ambient information system for mobile users.

Keywords

Ambient computing, ambient intelligence, context-aware information systems, mobile information systems

INTRODUCTION

People's information needs change as they encounter new situations. Meeting these information needs in a personalized and context-sensitive manner is one of the challenges of ambient computing and ambient intelligence. The motivation for this work has been to provide relevant information to the right situation and user in an ambient manner.

The trend in miniaturization continues as with the growing amount of handheld and embedded computers. Until recently, few applications and content services were developed and made available on such equipment. This, however, is already changing as we can observe the trend amongst telecom operators trying to channel content on top of providing network access. Digital content is, therefore, fully on its way into handheld and wireless networked devices. This seems to lead to an increased need for ambient information access. From the user's perspective, the thrust is about having access to and receiving relevant information in the situation. Seen from an ambient information management and retrieval perspective, it is about populating people's pockets and the surroundings with intelligent search engines that operate on ambient and distributed content repositories. One implication of this might be that digital information is effectively more close to the body on handhelds, personal belongings, and in clothes – or embedded inside objects, furniture, rooms, and open areas in the surroundings – ready for its distribution.

Our approach to addressing the challenge of information needs with ambient intelligence is by enhancing the surroundings with: ambient and proximity/vicinity-based content service access and delivery, digital content, miniature wireless web servers, micro search engines, and context-aware technology. The result is that relevant content can automatically be distributed and delivered onto each mobile phone in the vicinity of physical objects, rooms, and open areas. We demonstrate how one can distribute information relevant to the local situations to provide people with ambient information experiences, and also how this has a strong potential to meet their information needs in a more context-sensitive and personalized way.

DESCRIPTION OF THE DEMONSTRATION

As part of our vision about users, their interaction with the surroundings and their information needs, this demonstration shows the hardware and software we have developed for this purpose.

We have developed and implemented a system comprising general context-aware technology that is proposed as a solution with a unifying framework for exploiting user contexts in ambient computing. The overall architecture includes three cornerstones: a specifically developed tag (context tag), a content service provider, and the mobile user (with a mobile device), described later in section 3. The system integrates the developed tag technology with information from content service providers in order to deliver personalised, context-sensitive information

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wirelessly to the handheld device. The tag is a miniaturised computer, more than just an RFID tag. It can hold 128 MB of content and is Bluetooth enabled. It can also be WLAN enabled, and can be updated remotely via Ethernet. The demonstration will focus on the interaction between the tag, the mobile device, and the content as provided by a content service provider and how this relates to meeting mobile users' information needs. The system works with mobile devices which support MIDP 2.0. It has been programmed in Java J2ME based on CLDC 1.0, and uses JSR82 Bluetooth API, all now common on a variety of phones from different suppliers such as Sony Ericsson, Nokia, and Siemens.

We will bring several of our tags and demonstrate the working system which participants will be able to access using a mobile device such as a Sony Ericsson P900. A few mobile handheld devices will also be made available.

The content on the tags can be pushed to or pulled from the mobile device and presented on the screen – it can be delivered remotely from a content service provider through the wireless network infrastructure, or via the tag.

Users will also be able to see the types of content when in a relevant information zone. In an outdoor scenario, for example, as they approach the vicinity of the small and wireless tags a traveller can access content as they walk around a city. In an indoor case, this could be when close to objects at a museum, or in meeting rooms. The result is that relevant information can be provided to mobile users through more automatically captured information about the situation and by means of context-aware ambient technology. The retrieved content is shaped by the users' contexts. A context is, in general, constructed through the user profiles (typically local to a device) and the wireless tags that can be embedded in the surroundings.

Search engines are deployed on both the handheld device and tags. The screenshots in Figure 2 show how once a user logs in to the system, they can key in a search (picture 1) and see an ordered list of content items (picture 2). Clicking on a specific item would then display further details for that item (pictures 3, and 4). The figure shows a query "cathedral" and the display of the 1st and 4th content items from the initial result list. It is also possible to browse content via categories. A further feature is that pop-up content is also possible when in the vicinity of a tag. For example, information about the cathedral, such as in Picture 3, can appear on the user's phone when they are near the tag placed in the cathedral area.

We conducted experiments with the system in Seville, capital of Andalusia region in Spain, at locations where many tourists visit. The underlying content collection comprised of both general travel guide and local content for Seville. The general travel guide was an appropriate extract provided by Lonely Planet Publications. The local content was provided by Sevilla Global, which is owned by the City Council of Seville.

SYSTEM DESCRIPTION

The system integrates our own tag technology with information from content service providers covering both

Figure 0. Tag and mobile device

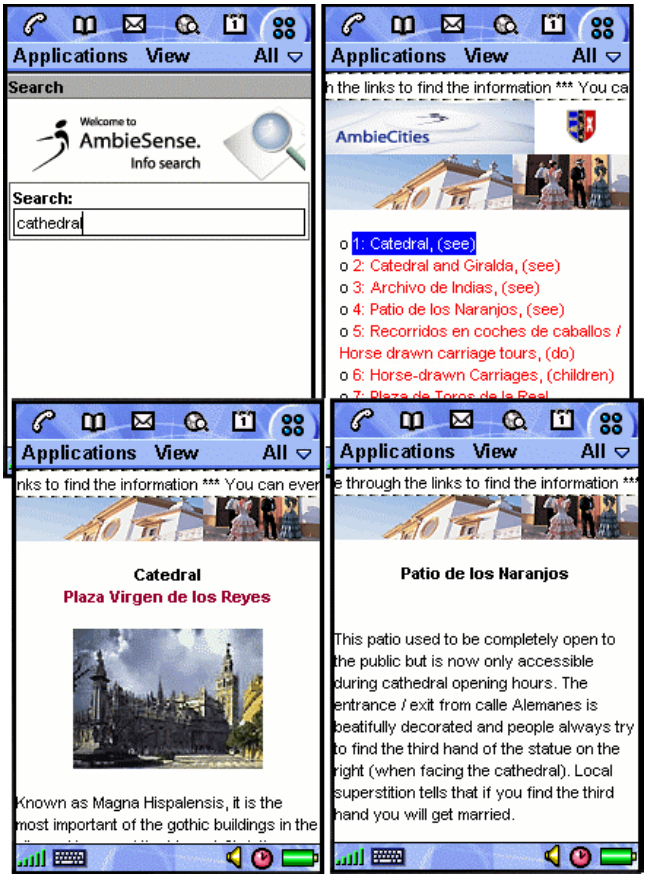

Figure 0.Screenshots of system on handheld device

general travel guides and local information, as described above. The overall system architecture consists of three main cornerstones: the content service provider; the mobile user; and the context tag (Figure 3).

The diagram illustrates the flexible ways in which users can access information. Content service providers may provide online information directly to a user (usually at a significant cost to the mobile user) or also via tags deployed in various strategic places thus creating an information zone. Information can be uploaded and maintained remotely (by content service provider or building owners, for example) but be accessible locally to the user who is in that environment and situation. For example, in the context of an ambient travel guide, the historic and cultural web pages, local sights, shops, maps, and local events can be communicated onto the mobile phones. Web pages could be uploaded on tags at relevant points, and be accessible to users at relevant places in the tourist city that they visit. The overall system reference architecture is described in further detail in [12]). The main components of the system, more briefly, consist of:

Content bases: Ambient and distributed content access is achieved via the content bases – a technology created within the project. The content can either be stored locally, or referenced by a URL. The content bases store content items. This type of information object holds meta-information about the actual physical content itself. The physical content can also be stored in the content base when the application stores a content item. This enables the application on the handheld device to be aware of, and access much more content than it has the capacity to store. In the demonstration there is a set of content items from a travel guide and news. It is relevant for both tourists and business travellers within a city. These items are structured with XML and are accessible at certain distributed locations in the surroundings. The content is indexed both on the handheld device and on the context tags.

User context middleware: This enables the system to deliver context-sensitive and personalized information. Information about the user and the user's environment is structured in a user context model. It contains information needed for a particular scenario and is attached to a specific location in the mobile environment. It also contains more individual information such user interest profiles (predominantly acquired automatically). When a user enters the vicinity of a tag, the user context is automatically enriched by aspects of the current surroundings. Moreover, contexts stored in the context middleware can also provide links to content items and content, thereby providing additional flexibility for retrieving/highlighting content.

Information search: Context-aware search (based on a probabilistic model) is performed to help retrieve relevant information objects. The information retrieval component is proactive and suggests results to the user. User context, at present, is used for a form of query expansion to improve precision measures.

Information zones: In order for the content service

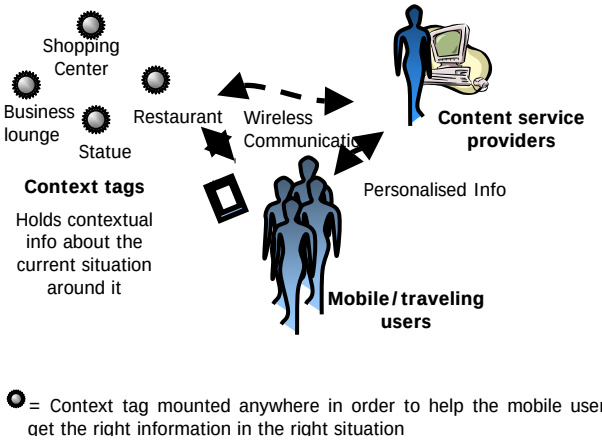

Figure 0. Overview of system architecture

providers to maintain information on the tags more easily, it is possible to define information zones. An information zone object groups several context tags together and ensures that the same content appears on all tags at the same time.

Mobile clients on the handhelds: These can be downloaded when a user is in the vicinity of a tag. It provides information search and distribution mechanisms.

Context tags in the surroundings: The tags mounted at various places in the surroundings provide an information channel for the user. A tag consists of hardware and software. It can detect the proximity (physical closeness) of handheld devices. These proximities can be configured for each tag to suit the situation or application needs. It is possible to channel the automatic distribution of content based upon the proximity.

RELATED WORK AND DISCUSSION

Related work can be divided into several levels: the vision level and subsequent usage scenario level; the information need, and retrieval level; the disappearing computer, sensor and wireless technology level.

The Ambient Intelligence landscape is a physical landscape where miniaturised and wireless computers are embedded in everyday objects like furniture, vehicles, and clothes [8, 9]. The idea is that humans will be surrounded by intelligent interfaces interacting with different applications. Other projects have coined ambient intelligence as the disappearing computer in the EU-IST Disappearing Computer initiative [6], e.g. e-gadgets [10], and Smart-Its [1]. The context tag developed within our project work described in this demonstration is an open and

interoperable device/ disappearing computer. However, this enough. Ultimately, what people really care about in the end is to have to have instant access to their information anywhere, anytime – and that it is available in personalised and context-sensitive way. This is why our vision was chosen to be: relevant information to the right situation and user.

The system described in this paper is related to work within the research areas of context-aware applications and location-based services for tourism. Some of the related work at the scenario level can be found in [3, 5]. Our approach differs from these due to the open and interoperable context tags, the context middleware, the content base, and associated search and retrieval facilities. The tags can be used across applications and services, and host several applications at the same time. The integration of the different technologies results in ambient, personalised, and context-sensitive access to information.

In terms of access to information, there are different approaches being taken at present. For example, Intel's Personal Server [13] involves access to personal information via small device that you would carry. It does not have display, but it links wirelessly via public infrastructures to enable access to personal data. The concept is like having access to your PC hard disk when mobile. The work focuses on the information already in people's personal storage. Our approach is to have information that might also reside with different content providers being delivered to a user's mobile device, but in a context-sensitive way based on location, preferences, etc.

At the information need, and retrieval level, contextual information provides an important basis for identifying and understanding users' information needs. Cool and Spink in a special issue on Context in Information Retrieval [4] provide an overview of the different levels in which context for information retrieval interest exists. They classify others' work in terms of information environment level, information seeking level, information retrieval interaction level, and the query level. Some of our earlier work cuts across several of these levels [7]. These categories are related and overlap. To this extent, the work described here has aspects in each of the four categories, but the first three in particular. The query level parts are not so much based on a linguistic analysis of the query but a case of augmenting or expanding it with contextual information.

Our approach to exploit context to augment information object complements other approaches to context-aware applications, because we see context as a mechanism to store, index, link, and retrieve digital content – hence to manage and retrieve relevant information users and situations. We focus on creating interactive information channels for the mobile user [11]. Most other approaches have used context either as means to adapt software, alone is not

devices, and network communication (e.g. [2]), or to analyse linguistic aspects of human input to the information system as referred to above.

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