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A Context-sensitive Information System for Mobile Users

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1. INTRODUCTION

The motivation for this work is to support the information needs of people with handheld wireless devices. The information needs change more rapidly as the people encounter new situations and environments, and hence it is likely to change with the changes of the user's contexts. From the user's perspective, the thrust is about having access to and receiving relevant information in the situation. Seen from the information retrieval perspective, it is about populating people's pockets and the surroundings with search facilities engines that operate on ambient and distributed content repositories.

At present, due to slow and expensive network connections, digital content for handheld devices is not hugely abundant. This is, however, already changing as we can observe the trend amongst telecom operators trying to channel content more than just providing network access. Digital content is, therefore, fully on its way into handheld and wireless networked devices, as was the case for personal computers and the Web in the early 1990s.

In short, an increasing amount of information, services and applications are becoming available to a mobile user, but it is hard to get what you need when you need it, and users have to wade through all the information, irrespective of their location or information needs.

2. DESCRIPTION OF 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), see Figure 1. The system integrates the developed tag technology with information from content service providers in order to deliver personalised, context-sensitive information 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.

We will bring several of our tags and demonstrate the working system which participants will be able to access using a mobile device. It they own a device such as a Sony Ericsson P900, they will be able to access using their own hardware, but otherwise a few mobile handheld devices will also be made available for those without their own.

Figure 1: Tag and mobile device

The demonstration involves a range of information:

- Travel guide content (Lonely Planet Publications) which can be browsed or searched for,
- Conference related information and business cards via the tag,
- Short news headline, event, or advert pop-up.

Figure 2: Screenshots of system in operation on handheld device

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 traveler can access content as he/she walks around a city. In an indoor case, this would be when close to objects at a museum, or in meeting rooms, for instance. 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 (picture 1), they can key in a search (picture 2) and see an ordered list of content items (picture 3). Clicking on a specific item would then display further details for that item (picture 4). It is also possible to browse content via categories. The last picture (picture 5) shows a popup item with a news headline at the top and an image advert. The installation of search engine and content can be done from the surroundings.

3. SYSTEM DESCRIPTION

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

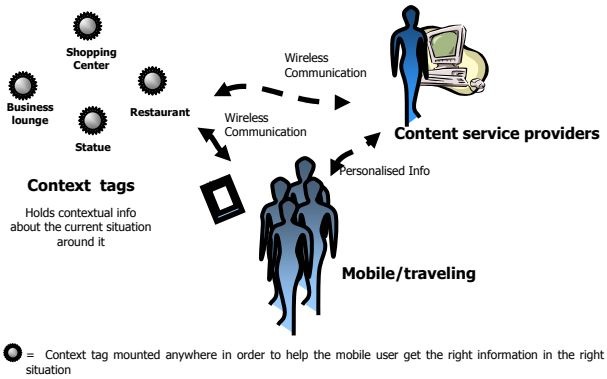

Figure 3: Overview of system architecture

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 a conference event, the program, schedule and announcements can be communicated in this way. Discussion papers could be

uploaded on tags at relevant points, and be accessible to users at relevant places.

The main components of the system 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 in the handheld device to be aware of and to 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 travelers 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 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.

4. RELATED WORK AND DISCUSSION

Contextual information provides an important basis for identifying and understanding users' information needs. Cool and Spink in a special issue on Context in Information Retrival [1] provide an overview of the different levels in which context for information retrieval interest exists. They refer to information environment level (e.g. Taylor [2]), information seeking level (e.g. Belkin [3]), information retrieval interaction level (this refers to user-system interactions but from a cognitive perspective can be said to relate to Ingwersen's cognitive communication model [4]), and the query level (e.g. as also discussed within TREC lately).

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.

Others have viewed context-aware retrieval more as a way of filtering results from normal retrieval techniques [5]. Related work can also be found in the fields of ubiquitous and context-aware computing. Dey et al, [6] in a special issue on Situated Interaction and Context-aware computing provide an overview. The focus from this perspective, however, has tended to be on location-based approaches and device contexts. Examples of these can also be found in few applications for tourists. Wider perspective of context has been discussed in some forums e.g. [7].

More specifically, however, related previous work involved the development a context learner for a probabilistic information retrieval system [3] in a traditional environment with a bibliographic search system. This was based on observations (within that environment) that users will tend to repeat searches or conduct a series of closely related searches over a period. Whilst each search must be regarded as representing a different information need they could be said to occur within a particular context. At present, the more general user context model [9] has a wider range of aspects which have been enriched as a result of the earlier work.

In summary, we have presented an overall architecture for enabling context-sensitive information systems which can take on board changes in both location and user preferences to achieve an efficient and extensible platform for information provision. Our system provides a method of achieving access to far greater amounts of information than normally manageable on a handheld mobile device while using context-sensitivity to make prevent problems of user overload.

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