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AmbieSense – interactive information channels in the surroundings of the mobile user

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Abstract

Ambient and universal access to information through a wide range of interaction devices is necessary to implement an inclusive information society. The technology used to implement ambient and universal access must support mobile and spontaneous use in everyday situations - in order to be useful for citizens. However, the full impact of ambient and universal access for mobile citizens will present new interaction design challenges. Some of these will be: (1) accessing the right information in the right situation and surroundings; (2) collaborating with disappearing computers embedded in everyday objects/ surroundings; and (3) the personalisation of technology and information for the users. These problems can be addressed by the integration of context-aware technology, disappearing computers in objects, wireless communication, hand-held computers, and net-based information services. Inevitably, completely new information channels *will* emerge under such conditions.

This paper presents the AmbieSense technology¹, which can be used as a way to realise everyday information channels that are ambient, content-sensitive, and personalised. The technology includes: (1) wireless context tags in the surroundings; (2) agents for mobile use; (3) net-based content services; and (4) context middleware. The paper also highlights the user context structure. The result of such an approach is that mobile travellers/ citizens can be provided with ambient and universal access to relevant and timely content as they move around and encounter new situations in the world.

Introduction

General user scenarios: Imagine that objects and rooms in your surroundings are able to instantaneously provide you with relevant information, and collaborate via your handheld PDA. You can walk close to a vase by the entrance for example, and it provides you with a map over the building. You sit down by a table at the local restaurant, and suddenly have access to the menu of the day. Later, in the hotel lounge you receive personalised news from the surroundings to your

¹ AmbieSense EU IST project: IST 2001-34244 (www.ambiesense.com)

PDA; Ambient and universal access can be implemented like this. The AmbieSense project develops and demonstrates such user scenarios.

How to implement ambient and universal access? Ambient and universal access [Stephanidis, 01] is about information sharing for anyone, anywhere, anytime. However, within the context of delivering information to users, simply opening all doors to all users all the time is chaotic. Restriction is not the answer either. Rather a solution lies in personalisation and context-awareness (viewpoints found in: [Brown and Jones, 01; Goker, 97; Dey and Abowd, 99; Korkea-aho, 00; Schmidt and Beigl, 99]). Personalisation is about focusing on the right person. Context-awareness is about the right time, right place, and right person (i.e. the right situation). Hence, ambient and universal access should include a design strategy that targets both individuals and situations.

However, the digital surroundings of a mobile user also, to some extent, need to be collaborative to provide the user with right information and applications. Existing wireless networks standards like WLAN, Bluetooth, and GPRS, cannot alone implement collaborative local surroundings/zones. A layer of collaborative and intelligent technology in the form of disappearing computers [Weiser and Brown, 97] (i.e. miniature computers embedded in objects and rooms) must be added between the wireless network and the mobile user in order to implement the general user scenarios described earlier. The widespread use of disappearing computers is a good means of achieving collaborative local surroundings for the mobile user. The AmbieSense context tags are a kind of disappearing computer.

Given the above assumptions, it is likely that user interface designers will need to design the interaction and the user interface of *both* the handheld computer *and* the disappearing computers. This can mean that the interface designers will need to adhere to multiple design disciplines – especially industrial product design. The main design challenge will be to design a collaborative and distributed interface, and to streamline the interaction between the objects, the disappearing computers, and the handheld computer (PDA).

New information channels that users can access in local surroundings like street corners, bus stops, restaurants, airports *will* emerge from such a design setting. They will take on different forms depending on the application domain. Also, the users' needs will change because it is no longer solely an office environment that will be the design arena but rather the situations in the world. These new information channels will result in *new* ways of interacting; the mobile users can pick up info packages from objects nearby, perhaps manipulate some of them, and sometimes send away new info packages into the Internet before they leave the surroundings.

The AmbieSense System Architecture

The AmbieSense system integrates context tag technology with information from content service providers in order to deliver personalised, context-sensitive information wirelessly to the handheld PDAs (see figure 1). A prototype with context tags, a content service, and handheld PDAs has been developed. In AmbieSense, context-aware and personalised applications can be built with the use of context tags, context middleware, and agents. The small electronic context tags are a means of capturing and communicating information about the surroundings. The context tags within AmbieSense are unique as they can store structured data and communicate it to mobile computers. Additionally, the tags can be updated with information from remote content services.

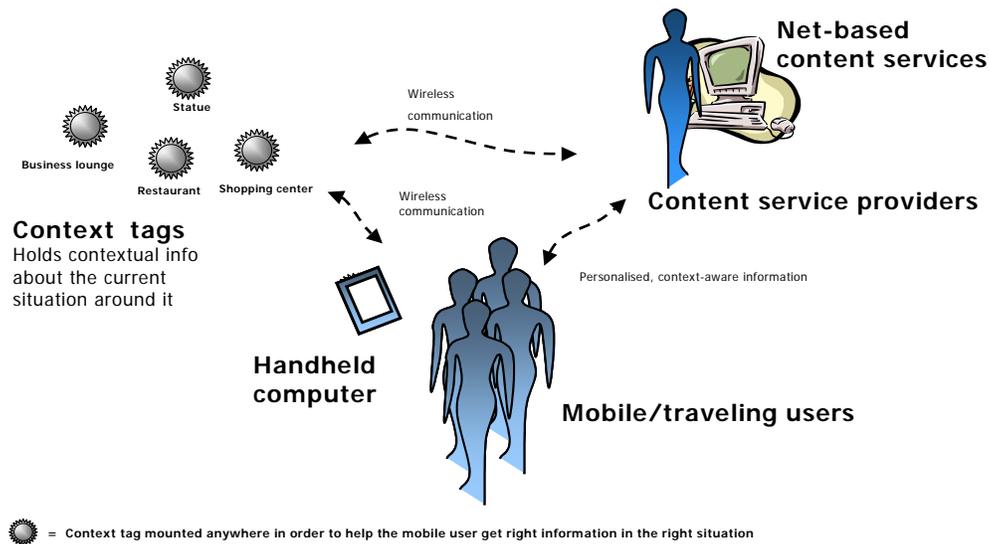


Figure 1: The AmbieSense system and users at an overall level

The general system architecture includes the following corner stones amongst others:

- **Wireless context tags** - disappearing computers embedded in the surroundings
- **Agents for mobile use** – autonomous components for personalised and context-aware delivery of content
- **Content services** – net-based content, which can be integrated with context, and delivered to users
- **Context middleware** – stores and maintains user contexts

Wireless context tags can be mounted everywhere – in buildings, within shops and restaurants, in vehicles, hidden in furniture, in user clothes, and even outdoors. The context tags automatically send the contextual information about the surroundings to the nearby mobile users. The effect is that they are relieved from specifying the context. Context tags can be integrated with existing computers and wireless network infrastructures.

Agents for mobile use personalise and adapt the content through information extraction, retrieval, filtering, and presentation techniques. These autonomous middleware components enable the collaborative surroundings. Personalisation is aimed via the use of the context middleware and the content services. The agents help the mobile users to get the right information to the right user context. The agents can be located on the handheld PDA and in the network.

Content services are instantaneously accessible for the mobile users as they encounter the various surroundings. The system's purpose is to relate the content to specific contexts. The content service provider can enhance a specific content service by utilising user context information. This will result in personalised and context-sensitive information channels in the local surroundings. The project will develop, test, and evaluate application prototypes for airport, city guide, infotainment, and maps.

Context middleware administers the user contexts belonging to individual users. Security and privacy mechanisms are used. A user context is capable of describing the user's interests, his state, the social setting, the spatio-temporal aspects, and other entities in the surroundings. The middleware is distributed on the handheld computer (PDA) and in the network.

User Context Structure in AmbieSense

The user context technology in AmbieSense is utilised by the context middleware. It is proposed as a unifying framework for exploiting user contexts within and across application domains. The user context structure is designed in order to enable effective matching and retrieval of contexts within and between applications. The approach is model-based as for intelligent user interfaces [Maybury and Wahlster, 98], and adaptive user interfaces [Myrhaug and Thomassen, 97]. All information is indeed part of the user interface. The user needs only the relevant information to the situation. Adaptation to the user's information needs – like in AmbieSense – is an iterative process based upon user contexts.

The AmbieSense user context model consists of five parts:

- Environment context
- Personal context
- Task context
- Social context
- Spatio-temporal context

Each part should be considered as a bag where you add or remove data items like: attributes with values, concepts and relations, data structures etc.

Environment context – this part of the user context captures the entities that surround the user. These entities can for instance be things, services, temperature, light, humidity, noise, and persons. Information (e.g. text, images, movies, sounds) which is accessed by the user in the current user context is all part of the environment context. The various networks that are in the surrounding can also be described in the user's environment context.

Personal context – this part of the user context consists of two subparts: the physiological context and the mental context. The first part can contain information like pulse, blood pressure, weight, glucose level, retinal pattern, and hair colour. The latter part can contain information like mood, expertise, angeriness, and stress etc. Some contextual information are quite static while others are rather dynamic in time.

Task context – this context describes what the persons (actors) are doing. The task context can be described with explicit goals, tasks, actions, activities, or events. Note that this also can include other persons' tasks (that are within the situation). For example, in a car with a driver and passengers, the situation can include the driver driving the car, passengers doing various activities such as reading, watching the car TV, listening to music on the personal stereo. The task context of the driver and the passengers will be different.

Social context – describes the social aspects of the current user context. It can contain information about friends, neighbours, co-workers, and relatives for instance. One important aspect in a social context is the role that the user plays in the context. A role can for instance be described with a name, the user's status in this role, and connections to the tasks in the task context. A role can, in addition, be played a social arena. A social arena can have a name like "at work" and have a geographical area.

Spatio-temporal context – this context aspect describes aspects of the user context relating to the time and spatial extent for the user context. It can contain attributes like: time, location, direction,

speed, shape (of objects/buildings/terrain), track, place, clothes of the user and so on. (i.e. the spatial extension of the environment and the things in it).

Conclusion and further work

We have presented the general AmbieSense system architecture with the main components. We can use this to implement new interactive information channels in the local surroundings of mobile users. The technology is currently under development. Prototypes with context tags, basic content services, handheld PDA's and proximity detection have been developed. When the components are complete, they will be subsequently integrated with several applications for travellers and tourists. The development process is user-centred and model-based. It includes both usability testing and indoor/outdoor pilot studies.

Ambient and universal access to information through a wide range of interaction devices is necessary to implement an inclusive information society. The AmbieSense technology is one means of achieving parts of this. It gives a taste of the near future where collaborative surroundings with new information channels interact with users, enabling them to pick up, modify, and send information packages.

It is important to design for individuals and situations when developing technology for ambient and universal access. Personalised and context-aware products and services should, therefore, be an integral part of this.

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