

# Contextualized Information Systems for an Information Society for All

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## Abstract

The paper describes some ideas about contextualized information services based on location, user, environment, and equipment awareness. An information society where people have access to information and communication facilities wherever they are overstrains people by information overload and selection and configuration effort if selection and presentation means do not consider the context of use. An example for a location aware adaptive information system is presented and discussed and future directions for enriched multi-modal information presentation are proposed.

## 1. The need for contextualized information

In an information society many people are no longer users of dedicated computers but they will be information and communication recipients, senders, or processors in a wide variety of contexts and with a wide variety of devices. Several research projects and applications on adaptive information systems in the past focused on scenarios where either a static user using a desktop computer or a mobile user stopping by at kiosk systems to pick up information were taken as a basis. New developments in the field of wearable and ubiquitous computing nowadays allow for using computers in really mobile scenarios. With the growing mobile usage of computers the need for new interaction paradigms increases because classical desktop paradigms do not work for this scenario, e.g., when walking around, even with a technically very sophisticated head mounted display, classical desktop interaction for manipulating information objects are not usable. One important consequence of that development is that accessibility problems become more relevant for all users. “Fully enabled” persons are in a similar situation like disabled people, because of restricted resources for interaction with the computer system in a special context. This shows up the need for approaching interface design and information exchange in a way to look at users and their available interaction resources based on their current interaction context and also gives a new view on the developments of interaction research for disabled people.

Information will be relevant and will increase both quantitatively (amount of information) and qualitatively (importance of information for the person) for more and more people. To cope with the information flow the person needs a contextualized view on the information available and relevant in a given situation. The contextualized view is specific for a person, a task, a location and the technical infrastructure the person is equipped with like the device and the communication bandwidth. A contextualized view is no isolated snapshot of an interaction situation. A contextualized view is embedded into a process of the person’s activity over time and space. Considering an individual’s activity process, including the social group the individual is interacting with, allows the system

- to select the information most probably relevant for the individual in the given task,
- to present this information in the most suitable way for the given environment and the given technical equipment
- to support the most effective interaction technique to receive and enter information and commands.

If information systems consider the demands of the person continuously in the process of activities they can support the person in an effective, efficient and pleasurable way avoiding information gaps and overload.

In this paper we will discuss some ideas about contextualizing interaction and building contextualized information systems and present an example for a contextualized information system, e.g. a nomadic museum guide “hippie” (Oppermann & Specht, 1999).

## 2. Context aware information systems

For adapting the interaction and information to an individual user and his/her current context several models for describing the context and the person’s characteristics are necessary. For describing the context of use (CoU) of an information system we need to define the parameters of context we want to consider for adaptation.

Several approaches have defined context models and described different aspects of context taken into account for context-aware systems. (Schilit, Adams, & Want, 1994) has mentioned: where you are, who you are, and what resources are nearby. (Dey & Abowd, 1999) discuss several approaches for taking into account the computing environment, the user environment, and the physical environment and distinguish primary and secondary context types. Primary context types describe the situation of an entity and are used as indices for retrieving second level types of contextual information. In most definitions of context four main dimensions of a context are considered:

*Location:* We consider location as a parameter that can be specified in electronic and physical space. An object or entity can have a physical position but also an electronic location described by URIs or URLs. Location-based services as one type of context aware applications (Schilit et al., 1994) can be based on a mapping between the physical presence of an object and the presentation of the corresponding electronic artefact.

*Identity:* The identity of a person gives access to a lot of second level type contextual information. In some context-aware applications a highly sophisticated user model holds and infers information about the user’s interests, preferences, abilities, knowledge and detailed activity logs of physical space movements and electronic artefact manipulations.

*Time:* The time is an important dimension for describing the context. Beside the specification of time in CET format. Categorical scales as an overlay for the time dimension are mostly used in context-aware applications (e.g., working hours vs. weekend, mapping onto a calendar of a person to get information about free vs. busy hours). For nomadic information systems a process-oriented approach can be time dependent and is used in workflow systems for selecting information in mobile working scenarios.

*Environment or Activity:* The environment of a context describes the objects and the physical location of the current situation. In several projects approaches for modelling the objects and building taxonomies or an ontology about their interrelations are used for selecting and presenting information to a user.

From our point of view contextualized information systems should at least take these four parameters into account for adapting the current CoU of a user. In the following section we will describe how we have modeled these dimensions in the development of Hippie and how we plan to extend the system in new projects.

## 3. A nomadic information system for exhibition visitors

The nomadic information system contains three models to identify the CoU. A *domain model* describes and classifies which objects of the domain information are to be presented and processed. A *space model* describes the physical environment where the nomadic system is used and the location of the domain objects in the physical space. A *user model* describes the knowledge, the interests, the movement, and the personal preferences of the user. The domain model and the space model are assumed to be static, i.e. the domain objects are described and their location is identified before the systems are used. If changes occur in the environment, the domain model or the space model has to be updated explicitly. The user models are dynamic, i.e. the users’

interactions with the information system and their movements in physical space are evaluated to update the user model automatically.

The nomadic information system Hippie has been developed for a cultural environment, providing information about two domains, an art exhibition and a fair. The nomadic user is supported in the course of the preparation of a visit, during the actual visit, to the evaluation of a visit by contextualizing the interaction to the current CoU.

For the preparation of a visit hippie supports the user in:

- individual information access with annotation and communication possibilities,
- awareness about events in the physical space by combinations with awareness platforms like described in (Gross & Specht, 2001). By infrared sensors connected to significant positions in the physical space (exhibits, transits) and infrared receivers and electronic compass connected to the client of the visitors,
- adaptation of information to interest, knowledge and preferences of visitors by adaptive tour proposals and content adaptations, and
- graphical understanding support of exhibits for non-experts to initiate advanced viewing.

During the visit the user is supported by:

- a high quality 3d audio soundscape,
- a high precision localization system for location aware information selection and presentation, and
- intuitive interaction facilities, like physical information points and information selection by gestures and movements.

For evaluating a visit a nomadic user is supported by:

- detailed reporting of a past visit,
- recommended facilities for extending the current knowledge and arousing interest.

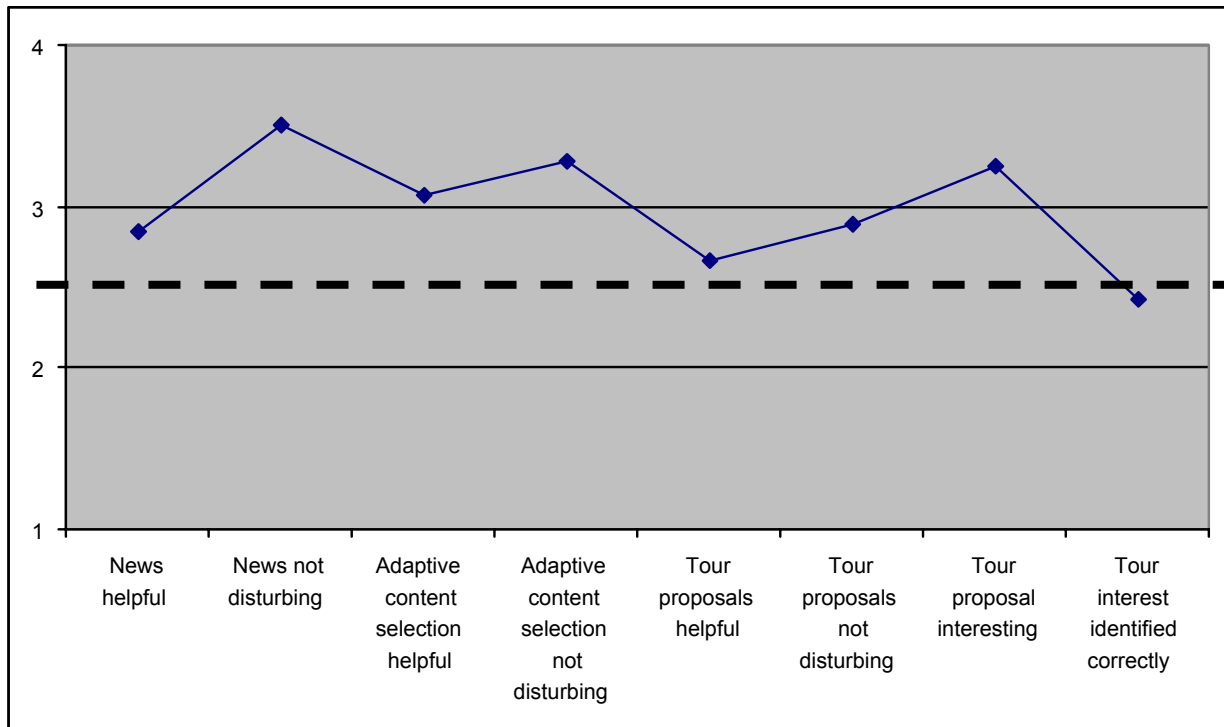
Contacting tools for visitors in other CoU for cross reality discussion see (Gross & Specht, 2001). The prototype "Hippie" has been implemented for an art exhibition in the castle of Birlinghoven, the headquarter of GMD in Sankt Augustin. Evaluation experiments were conducted with 60 visitors using three comparative guidance media. The results revealed that the prototype was effective to support the visitors in their knowledge acquisition about the art domain. It turned out that for user satisfaction of novices the computer handling needs improvements. This effect is due partly to the hardware device that is still too heavy and to difficult to use while roaming.

A main interest for the evaluation was the adaptive user support by the system. Assessing adaptive features of a system is a difficult task. Adaptivity evaluates the user history and can be the more valid the more data about a user can be collected. In experiments access to user data is typically limited. The time for evaluation studies is restricted. In the current study usage sessions varied from .5 to 1.5 hours with a mean of 69 minutes. To present adaptive tour proposals for the visitor during the time period of the experiment, the system can not analyse more than around 30 - 45 minutes visiting recordings to evaluate the user interests.

In the experiment conducted we mainly evaluated three adaptive features of the hippie prototype:

- *Adaptive exhibit recommendation*: Based on the localisation of the visitor and an internal model of the physical space, the system proposed objects that where close to the user.
- *Adaptive content selection*: Based on the user's previous exhibit presentations the prototype adapted the detail of information presented about an artwork to reduce redundancy of presentations and to arouse user's interest with additional information.
- *Adaptive tour proposals*: Based on the user's movements in physical space and on his/her information requests about exhibits the prototype proposed tours of exhibits that where similar to the estimated interests of the user in the user model.

60 visitors were invited to use different information media: a traditional guidebook, a simple audio guide and the Hippie system. 20 visitors used each of the three media for intensive use and the other two media for short supplementary tasks. During these tests 18 of 20 Hippie users assessed the announcement function of the system showing a new exhibit near to the user by answering 2 questions in a questionnaire. 14 of 20 Hippie users assessed the adaptivity of the system providing a personal information space by selective information presentation and responded to 2 questions of a questionnaire. 8 of 20 Hippie users used the adaptive tour function of the Hippie and responded to 4 questions of a questionnaire.



**Figure 1: Assessment of adaptive features of a mobile exhibition guide Hippie**

Figure 1 shows the mean values of the visitors' assessment of adaptive system features. For the assessment a Likert scale was used with four categories: 1 = completely disagree, 2= disagree, 3= agree, 4 = completely agree. The dotted line marks an assumed neutral line 2.5 where assessments are neither positive nor negative.

The results for the „New exhibit“ announcements show positive support for the idea to automatically inform the visitor about exhibitions the system can give explanations about. The mean of the helpful-assessment is  $M=2.8$  and the assessment that the „News“-announcement not being disturbing is even  $M=3.5$ .

The system takes into account the visiting history of the visitor for each exhibit. The first time a visitor gets the full information set being appropriate according to the user interest model. The second time the presentation encompasses only the basic content (name and thumbnail of the exhibit) together with access to further information content via attribute buttons. This is meant to be a way to prevent the user from information overload. The assessment of adaptivity for re-approaching an exhibit based on the already presented information during the visitor's first approach is rated highly helpful ( $M=3.1$ ) and evaluated as not-disturbing ( $M=3.3$ ). This feature reflects the knowledge the user is assumed to need when coming to an exhibition.

The assessment results for the adaptive tour function show that the adaptive proposal of an exhibit tour matching the personal interests of the visitor is appreciated by the subjects: it is in particular interesting ( $M=3.3$ ), helpful ( $M=2.7$ ) and not disturbing ( $M=2.9$ ). The “Tip” was announced by a three times blinking bulb with a following report of relevant exhibits seen by the visitor constituting the hypothesis of a tour interest and a tour proposal.

The question whether the tour proposal meets the actual interests of the individual visitor was assessed critically: The value of 2.4 is less than the neutral 2.5 what means that more than half of the subjects were happy with the proposal content; the answers to this question showed the biggest variance between the subjects.

To conclude, the adaptive features of the prototype turned out to be helpful for the visitors. Announcements of relevant exhibits, adapted information content and adapted tour proposals were appreciated. More extensive evaluation of user interests by the user model is needed to enable the system to propose exhibit tours adapted to the actual art interests of the visitors.

A main criticism in expert workshops and a main result of the user evaluations was the complicated interaction with small laptop computers, table PCs, or even with wearable computers like the Xybernaut™ MAIV. Therefore for supporting a usable and intuitive interface for mobile users during a visit we try to develop a completely new kind of interface in the project LISTEN (<http://listen.gmd.de>). In LISTEN the user wears a lightweight headphone that displays 3d audio information and his/her movements in space will be tracked with an adequacy of 10 cm and 5 degrees. The high quality of audio material used in LISTEN and the 3D audio rendering will allow for intuitive interaction of the visitor with his/her physical environment while splitting resources in a traditional and well-known way. The visitors *look* to the exhibits and *listen* to the explanations of a guide or are embedded in an audio augmented soundscape.

The aim of CRUMPET is to implement, validate, and trial tourism-related value-added services for nomadic users (across mobile and fixed networks). In particular the use of agent technology will be evaluated (in terms of user-acceptability, performance and best-practice) as a suitable approach for fast creation of robust, scalable, seamlessly accessible nomadic services. The implementation will be based on a standards-compliant open source agent framework, extended to support nomadic applications, devices, and networks.

With these developments we are trying to realize prototypes that come closer to a real nomadic system with adequate interaction facilities for different CoU and a continuous support for a nomadic user based on a user model, a world model, and additional information about semantics of the world model in taxonomies.

## 4. Conclusion

For an information society to allow people to receive and process information and communicate suited to the current context of activity context aware services are needed. The context can be specified by location and activity tracking of the user evaluating the position and interaction of the user based on a model of the task or interest of the individual, the current physical environment and technical equipment. The examples shown in the paper demonstrate current solutions and future demands to enrich the contextualization of the information selection and presentation for seamless roaming. For content selection modelling of the user and the environment is crucial, for information presentation and interaction modelling of appropriate modality like visual and auditory display needs further development.

## Literature

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