Adaptive Information for Nomadic Activities. A process oriented approach

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Abstract

The paper describes the idea and the structure of a mobile information system under development in the HIPS[1] project that allows for supporting nomadic activities. Nomadic activities are a widespread class of human activities. Many activities are distributed in time, space and social groups. In contrast to print media till now electronic information and communication media did not support nomadic activities. The worldwide Web, wired and wireless connectivity to networks, and small mobile devices now allow for supporting nomadic activities by information and communication technology to an extensive extent. The paper describes ideas for the application of technological potentials for art excursions as an attractive class of nomadic activities. For the fit of user interests and needs adaptation facilities are described, to reflect the current user's local position (contextualisation) and interaction history (individualisation).

Zusammenfassung

Der Beitrag beschreibt die Idee und die Struktur eines mobilen Informationssystems, das im Projekt HIPS entwickelt wird und die Unterstützung nomadischer Aktivitäten erlaubt. Nomadische Aktivitäten sind eine weit verbreitete Klasse menschlicher Aktivitäten. Viele Aktivitäten erfolgen zeitlich, örtlich oder sozial verteilt. Im Gegensatz zu Druckerzeugnissen haben bisherige elektronische Informations- und Kommunikationsmedien keine nomadische Aktivitäten unterstützt. Weltweite Netze, drahtgebundene und drahtlose Verbindungen zu Netzen und kleine mobile Geräte erlauben mittlerweile auch die Unterstützung nomadischer Aktivitäten durch Informations- und Kommunikationstechnik. In diesem Beitrag werden Ideen für die Anwendung technologischer Potentiale für Kunstexkursionen, eine attraktive Klasse von nomadischen Aktivitäten. Für die Berücksichtigung von Benutzerinteressen und –bedürfnissen werden Anpassungsmöglichkeiten beschrieben, die die aktuelle örtliche Psotion (Kontextualisierung) und die Interaktionshistorie (Individualisierung) berücksichtigen.

Keywords: *Nomadic Activities, Mobile Computing, Contextualisation, Adaptive System, Museum Information System*

1 Introduction

A challenging feature of current IT development is mobile information technology [1]. Till now people using information technology were fixed to their hardware station (desktop). Currently two technical developments contribute to overcome this restriction. There are small computers like laptops and now even palmtops that allow for mobility in the physical space not being cut off from information technology. And there are net facilities that allow for accessing any information from any point in the physical space—given the user and the information is connected to a network. These developments support nomadic users using mobile information technology.

Mobile information technology may be curse or boon. It may fix the user to a technical system reducing or substituting the concentration on the real environment. Mobile information

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1 The project Hyperinteraction within Physical spaces (HIPS) is an EU-supported LTR project in ESPRIT I3. The partners of the consortium are University of Siena (co-ordinating partner), University of Edinburgh, University College Dublin, ITC, SINTEF and GMD, CB&J, and Alcatel.

technology may so be a distraction and may reinforce one's obsession. But mobile information technology may also be a chance. It may support ongoing activities from the beginning to the end. Traditional media like files, literature, memo-books are limited in accessibility. On tour the user can only read those office files or private books that he or she has put into the suitcase before leaving for a journey. The fit of the selection to the actual needs is typically very limited.

Many activities are distributed over time, over space and between actors. Nomadic media allow for accessing information that are needed in any period of the activity at any place and together with any partner involved. The actor is not released to plan his/her activity but he or she is not required to plan the access to all information and all co-actors needed in several phases beforehand.

Another challenging feature of current research is the adaptation of the selection and presentation of information according to the user's needs [2] [3]. The user uses different devices with specific characteristics and restrictions both for information access (bandwidth) and information presentation (size and resolution). For mobile information technology the particular challenge for adaptivity is the support of users at different locations of the user's interaction with the system. Accordingly nomadic adaptive systems require both a user model where the information according to user needs, knowledge, and preferences is evaluated and a usage model where the information according to the current connectivity and hardware and software is held up-to-date. To achieve this, mobile information technology can be combined with technologies to identify the users' working environment and his or her position in the physical space [4]. Infrared or General Positioning Systems (GPS) allow for contextualising the device of the user in the sense mentioned above. The position and the movement in the physical space can be observed and evaluated for required information [5].

In this paper we want to discuss demands and possibilities for an adaptive information system with devices for nomadic activities distributed in time, in space, and between people. To illustrate the application of a mobile adaptive information system art excursions are selected including the preparation, the execution, and the evaluation of a museum visit. The navigation in the physical and the navigation in the information space are used as indicators for the user's interests, preferences, and the knowledge acquired so far.

2 Adaptive Information Support for Nomadic Activities

2.1 Activities in distributed time, space and social setting

Most human activities are not fixed to a particular point in time and space. Many activities evolve and by their nature they are distributed in time and space. They may be executed at different places and the execution may be interrupted by other activities. Activities often involve several people. Activities are planned by and for several individuals or groups. They are more than individual short term acts at one place. Extensions of activities can thus be described in three dimensions: extension in time, extension in space, and extension in communities.

- *Extension of activities in time*

  Traditional IT-based systems support human activities by providing massive power to store and retrieve information. There has been effort to reflect the goals and the context of the user by adaptive features or agents to select a relevant subset of information for a given task for a given user to overcome the information overload or misfit. Machine memory is supposed to reinforce human memory. Memory power can be used to refer to information across time. Human capacity is powerful for the information processing in the present; human capacity is selective and unreliable for retrieving information from the past and storing information for the future [6] [7]. For nomadic activities mobile information technology can support full information access at any time, i.e., from the past and for the future, with information retrieval specific for a given activity phase.

- *Extension of activities in space*
Modern network-systems support human activities by providing access to information resources at different places. They reinforce the mobility. The user can be mobile and can have access to information wherever he or she is, or the information can be mobile and the user at a constant place gets access to the information. The requirements for the information content and the information presentation vary for different places. Hardware and output features of information systems have been adapted to local constraints of usage long before laptops and palmtops complement office workstations. For nomadic activities information technology needs to support multiple device information access at any place and position aware (contextualised) information retrieval.
- *Extension of activities in communities*
Group support systems have been developed to contribute to the communication and co-operation of users. They reinforce the communication, co-operation or competition. Adequate technical support of human communication, co-operation and competition must reflect human behaviour to be empathic, role taking, and ambiguous. Reliable access to a communication and a communicator in any time and at any place has to be combined with the need of people to follow their own tasks and preferences not affected by obtrusive communications. For nomadic activities information technology needs to support access to communication tools at any time and place and social constellation aware communication exchange.
Integration of the extension of activities in time, space and communities
For an information and communication system to support human activities it is central to consider an integration of the requirements of the described features. For an appropriate support it is not enough to provide any information at any places in any time for anybody. The specific tasks and goals of an individual and his or her communicators, co-operators or competitors at specific points of time and space have to be taken into account. The adaptation has to consider the demands from the phase of the activity.

2.2 Adaptivity for nomadic activities in the physical space

Mobile adaptive information systems should support human activities considering time, location and social constellation in the physical space and the user's navigation in the information space. Nomadic activities–by its definition–take place at different places. Different devices support access to information technology at different places. In the office the user typically uses a well-equipped multimedia PC. At home the user has possibly low connection to the Internet via modem. During a journey the user is equipped with a laptop or a palmtop with low connectivity and display size. The system can be adapted to the specific conditions of the given place. It can prepare the connection to the Internet, adapt the composition of textual, graphical and video elements and adjust the presentation to the environmental conditions. Activities at different places allow for different interaction with an information system. In the office or at home the information system is the central focus of the user's attention. He or she is sitting in front of the system, selecting, reading and writing information presented on the screen. Outdoor the user interacts with objects within a physical space and the attention is directed towards the physical and social environment. The presentation of information by an information system should reflect the absorbed (mostly visual) sense of the user. Instead of visually displaying information audio output via headphones may be more suitable for a user while additional visual cues may be designed to complement the understanding of or the navigation through the audio information.

Audio presentations allow for viewing the physical environment supported synchronously by complementary information. Different modalities of perception have advantages and disadvantages for the recipient. Audio presentation is weak in providing control for the user. Control only allows for start, pause, move back or forward, and stop. Selection of parts of information and information about the kind and the length of the information is not supported. Compared to visual information audio output has to be received by the user sequentially. The speaker or more generally the audio composer defines the sequence of the information. The user can't scan audio information and can't address interesting parts selectively. The combination of visual and audio presentation offers the chance to integrate descriptions and explanations, but it also implies difficulties. Given the identification of an ideal sequence of perception and an ideal match between visual and audio information the synchronisation of visual and audio presentation requires the evaluation of the recipient's visual perception followed by synchronised audio output. One option is that the recipient controls the presentation by his or her eyes. In this case the visual perception of the recipient has to be identified by an eye tracking system that is at present only applicable for experimental environments. The alternative option is to guide the recipient by audio presentation followed by synchronised visual perception. In this case the recipient is fixed to the guidance of the audio presentation. To compensate some of these shortcomings the user could be given a visual display at least of the length and some characteristics of the kind of audio output. The length of an audio message could be displayed numerically and analogously. The characteristics of information could be displayed by a sequence of keywords (like vita, composition, geographical outline) or by a sequence of icons (like heads, sketch, maps). Elements of the sequence could be selectable for the user.

Adaptivity for nomadic activities should take device and bandwidth constraints into account and adapt to environmental and activity constraints.

2.3 Adaptivity for nomadic activities in the information space

Traditional adaptivity approaches also apply for information processing supporting nomadic activities. For the selection and presentation of information during nomadic activities additional indicators for the user's needs can be obtained from the context of use during the nomadic activity. Preparing an activity needs information different from the execution of the activity and the evaluation of an excursion needs yet another set of information or editing demands of information. During the execution of an activity the physical environment provides objects the user can refer to. During the preparation or evaluation phase of the activity the physical objects probably need to be visualised by a graphical representation. Following the user's activity process the user model of the system can evaluate the history of navigation both in the physical space and in the information space. The model can describe the information used by the user and the places visited by the user.

The adaptation of the selection and presentation of the information to the user supports the combination of new and familiar information for the user. For information behaviour in general and for learning behaviour in particular it is preferable in terms of effectiveness, efficiency and satisfaction for the person to learn new elements embedded into a familiar frame. The connection between already learned and still to be learned elements is essential for the learning success. Repetition is a reinforcing factor for learning. Combining new and familiar items can augment not only learning results. Also the enjoyment of attraction environments can be increased when the person gets new aspects of an already known topic. The actual and the perceived level of difficulty, i.e., the (preferred) relationship of new and old elements is a central issue in pedagogic. Self-assessment of discrepancy between own abilities and knowledge and the demand level of tasks control the achievement motivation of learners. Such factors are highly personality specific. They may depend on the learning history of the person. Success-oriented learners may be more open to new information than failure-experienced learners. One person feels uncomfortable and lost in information space when many new items are presented; others may enjoy serendipity in an innovative environment that provides stimulation and surprise [8, 109] [9, 55f]. Exploration as active and self-directed learning [10] [11] can be supported by an Exploration Space Control as proposed by [12] to prevent people to get lost in the information space but still providing a rich learning environment. What is true for learning also holds for more general experience. Understanding and enjoying reality most probably is effectual if new elements can be based on already known ones. This makes it yet more demanding and attractive to adapt the information to the person's individual knowledge in the given domain.

3 Information system for art excursions: A scenario

3.1 Description of the scenario and its aim

This chapter illustrates the application of a mobile adaptive information system for art excursions in a museum. A visitor is assumed to prepare the excursion to a museum at home by consulting the system via internet reading descriptions and recommendations or viewing representations of paintings. The user's information selection is the initial basis for the user model developed for the adaptive behaviour of the system. Being on site the visitor enters the museum and gets a palmtop device with the mobile system and contextualised information about the exhibit he or she is currently in front of. The visitor can walk through the exhibition following own ideas while the system supports the exploration by contextualised (adapted to the current position) and individualised (adapted to the interest and knowledge) descriptions and comments. He or she can also select a guided tour prepared by the curator of the exhibition or composed by the system based on an inference of interest and knowledge developed in the user model or the user can define a tour specified by explicite selections from the exhibition list.. Before, during, and after the visit in a museum the user can enter and exchange own notes, comments, and communications about his or her impressions for own or others' benefit. The evaluation of the selected exhibits and the selected information about the exhibits allows the system to update the user model continuously.

3.2 Empirical basis of the scenario

The scenario is based on observations, interviews and questionnaires performed in 5 museums in 4 European cities in the consortium of the HIPS project [13]. The design of the prototype of the system has been stimulated by consulting relevant literature about art and art reception of people being interested in art but are no experts or artists themselves. The empirical findings lead to several scenarios written by partners of the project consortium that are to guide the design, implementation and evaluation of the system. In this paper we don't describe the scenarios in detail but we only give the essentials for the understanding of the approach and of the presentation of information and the interaction of the user for the specific environment of art exhibitions.

3.3 Content of the scenario reflecting the demands of different phases

The art domain is attractive for mobile information technology first because art excursions require nomadic activities from visitors. Second, art can best be enjoyed when the art recipient can combine the impression of an art exhibition or an art event with meta-information synchronically explaining aspects of the art not being presented by the artwork itself.
Art excursions are typically planned at home reading books or guides. In future more then at present excursions will also take advantage of information systems given that more material about art and excursions is electronically available and mobile information technology more widespread used. During different phases several kinds of equipment can be used. At home an internet-connected multimedia PC provides information to be consulted, articles and notes prepared and to-do lists created for the journey. A visit of a city with several museums may be prepared by browsing through a list of contents of the museums, reading some descriptions of exhibited art works or artists. In this phase and this environment, i.e., at home without having the artwork in front of one's eyes, the user, for instance, is happy with a graphical representation of the artwork together with its explanation.
During the journey the system should offer seamless access to the previously collected information, for example, on a palmtop via a wireless local network. The presentation can take into account the already provided information and the current position of the user identified by infrared (indoor) or GPS (outdoors). In front of an artwork a high-resolution representation of the work is dispensable. If at all the user needs a silhouette of a painting and opportunities to address areas of the painting he or she wants to ask questions about.
For a system that users can use at several places the input and output of the system have to support immersive interaction. The user can concentrate on his or her activity in the physical and social space and is supported by an additional information layer of a virtual space with complementary information. For the viewer of a painting, for example, several options of verbal comments about the artist, the art period, the art style, the art technique etc., are provided to increase the intellectual benefit of the viewer without reducing his or her visual gusto. Roughly on site, in more detail before or after the visit the user can explore the painting style by overlaying the painting with typical outlines specific for the given or for a contrastive style. Virtual copies of a painting allow for exploring and manipulating its composition and presentation characteristics including explanatory support by remote experts via the net to increase the benefit of the viewer.
The following figure shows the structure of the usage in front of an example fresco (the *Guidoriccio da Fogliano* by Simone Martini).

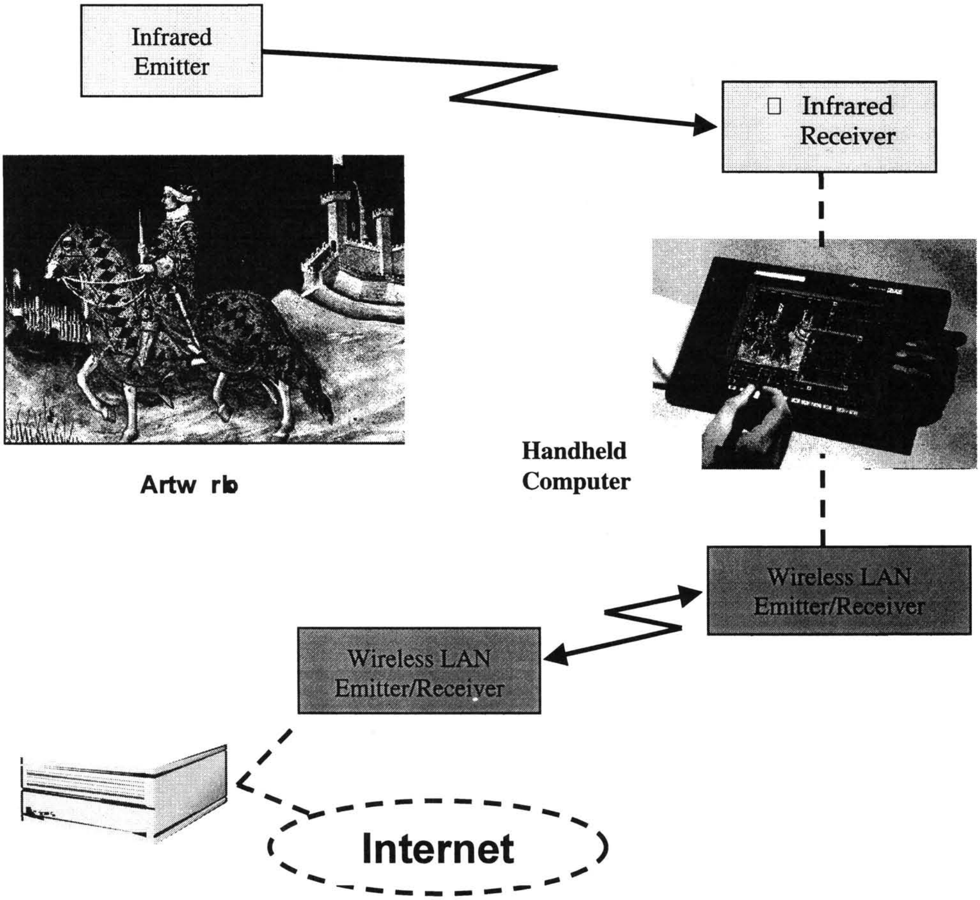

Figure 1: Structure of the system with an exhibit example

3.4 Main modality of system output in the scenario

What is further to be adapted to the user is the modality of the output of the system. During the visit of a museum the user wants to focus the attention on the exhibits, i.e., he or she wants to see the *Guidoriccio da Fogliano* in the example fresco in figure 1. Traditional print media like small labels attached to the exhibits, leaflets, and guidebooks compete with the art attraction itself for the attention of the visitor. The visitor has to switch from viewing the painting to viewing the description of the painting. Visitors of museums often spend plenty of time reading the small labels attached to the displayed items—sometimes as much time as they view the artwork itself. Many visitors consume exhibitions only by passing by the labels of the exhibits one after the other because it is of central interest for visitors to know the artist and the given title explaining the subject of the artwork. In the questionnaire-based study [13] we have found that visitors with more intensive art interest use to vary the distance and the perspective with respect to the artworks. During this navigation in front of the item none of the positions allows for reading the labels so that yet another position is required for reading the short artist and artwork information. More extensive written information requires chan-

ging if not the physical position but at least the focus of attention in the information space: from the artwork to the art description in a guide book.
The visual channel being absorbed by the physical environment audio presentations can suitably intensify the benefit of a visit. Experience with multimedia shows that the combination of several media into one device, i.e., the computer, is not enough to increase the benefit from multimedia presentations [14, 7] [15, 181]. Different modalities (sensory channels like eyes or ears) and different coding (like text, picture, table) have to be carefully composed on the media to suite the needs of the recipient. In museums audio guides like a Walkman, a Discman or a human guide are esteemed for their complementary modality. Systems have already been developed to take the position of the user into account when playing audio comments from a Discman [5]. But the presentation offered by these media is a standard one in terms of the visitor's knowledge, interest or time. More tailored audio presentation combined with visual silhouettes and textual summaries can be a complementary attraction.

3.5 User input of information and communication

The planned system does not only provide information output in different modalities and coding. It also is to allow for user entry and editing. Based on media available on site, like local guides, brochures, catalogues, etc., additional information can be collected during the execution phase of a journey, for example in the form of notes and attachments to previously collected information items. After the trip all information collected before and during the trip can be made available by the system for the visitor's evaluation using updating and editing facilities. While on tour the palmtop is the preferred device. At home again an internet-connected multimedia PC will be used.
The user is supported by the information system during *all* phases related to his or her journey through the provision of access to a familiar information warehouse, despite of the diversity of environmental surroundings. The system relieves the user as far as possible from the burden of this diversity. By employing global positioning information, the system automatically identifies technical constraints relevant for data transmission and presentation and automatically adapts according to the user's individual or group needs, given a specific point in space and time. The user can define hotspots for his or her journey during the preparatory phase and can count by predefined hotspots on the system's notice at the relevant situation during the execution indicated by specific space and time parameters.
Some art excursions are performed individually but most visitors come with friends or their family. In order to support social activities, the system has to support the access of several users with defined access rights to information resources and supports the exchange of information during the progress of activities wherever they take place. Information to be exchanged may be art oriented hints, questions or recommendations to other visitors but communications may also be of pragmatical intention to make appointments for a coffee break or the like. Restricted communication may be provided for a dedicated community (group, family) or public communication can show information and interpretation of individual visitors complementing official visitor guidance given by the museum curator.
The scenario integrates mobile appliances with communication and geographical positioning technologies in order to allow for interactions between geographically dispersed locations based on a multi-modal mobile access to distributed information resources, adaptive and adaptable information processing and presentation features. Intuitive interfaces on the background of user's experiences and environmental conditions reflect the user's needs.

4 Conclusions

The scenario stimulates ideas for future systems. Mobile adaptive information systems can be designed to be location aware for the current position of the user and to reflect both the user's navigation history in the physical space and his or her interaction history in the information space. Such systems can enrich the benefit of a nomadic user when developing activities over time and space and in communication with other users. The cut off from information and communication while moving in the physical space can be reduced, the selection of information can be adapted to the needs of the user at particular time and space and the presentation can be optimised due to the not-engaged modality of the user's perception.
The ideas described in this paper will be implemented and evaluated empirically[2]. Massive prototyping in the consortium will allow to follow different approaches in the design of the system and to evaluate the alternatives at different levels. The first level of evaluation will be the interaction level. How can users use the system, what techniques and metaphors are more and what alternatives less appropriate for the user to interact with the system?
The second level of evaluation will be the user's benefit of the system. Is the tour more attractive and more successful for the user? Gets the user a more continuous and richer support for the process of the activity and a better understanding of and a more positive feeling about the activity domain, e.g., the art exhibition?
The third level of evaluation addresses the implications and consequences of the system from a more general point of view. Is a user with a mobile information system a more autonomous user who can concentrate on the items of interest in the physical space of attraction? Is the information system the active guide the user becoming the receptive client? Determines massively available information the kind of reception and interpretation of the physical space of attraction? Enhances the information about the physical space of attraction the cognitive perception of the world reducing affective immersion?
The described questions will be evaluated empirically in trials based on mock-ups and prototypes of different scenarios. A first prototype has been developed by GMD for the castle of Birlinghoven and its art collection. The system can be used on-line to explore ideas of the information presentation or to simulate a preparation of a visit. To start the system use the link from the HIPS-homepage of GMD: http://zeus.gmd.de/ projects/hips.html. The prototype will be evaluated with real visitors of the art exhibition.

5 References

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2 A prototype will be prepared for an open day of GMD at the end of September 1998.

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