A ubiquitous interaction model for a natural and cultural heritage museum proposal of the Montsec area

Montserrat Sendín, Jesús Lorés, Carles Aguiló, Xavier Palau[↑]

Department of Computer Science and Industrial Engineering.
University of Luida, 69, Jaume II St., Luida
Tlf: 973.702.700 Fax: 973.702.702
e-mail:{msendin, jesus}@eup.udl.es
URL: http://www.udl.es/dep/diei

[↑]Joan Oro Foundation Scientific Manager
11, Rovira Roure, St., Lleida
Tlf: 973.239.505
e-mail:fjo@fjo.es

Abstract

In this paper we present an interactive model to be applied to the natural and cultural heritage museum proposal of the Montsec area, based on one of the emergent interaction paradigms nowadays -the ubiquitous computation-. The Montsec is a mountains range located in the prePyrenees of Lleida (Spain), characterized by its extraordinary and multi-thematic wealth.

The potential of the ubiquitous computation has had a substancial growth due to the new advances in mobile telephony and wireless computation. In our case, any visitor of the park will dispose of a third generation (3G) telephone which will permit to identify the user and offer him all types of information adapted to his consulting and interactive guide necesities, which will be customized according to the characteristics, position and other parameters of the user. This turns our information system into a valuable itinerant multimedia material, fulfilling with the ubiquity principles. We pretend the whole area to be visited behaves like a true "interactive space". Furthemore, the presence of an interface agent in the system will facilitate to a great extent the interaction, integrating that way the paradigm of the indirect management too.

In short, our objective is to create a project designed to the preservation, management and diffusion of the real state and resources of the Montsec through the use of the new technologies, which is presented like a museographical proposal.

Key words: direct manipulation, indirect management, interface agent, ubiquitous computation, mobile terminals, ecomuseum.

1. INTRODUCTION

Over the last years our research has been based on the development of interactive systems mostly applied to the cultural and natural heritage. We have used direct manipulation, real time and virtual reality interation styles. We can make mention of the Studium project (a reconstruction of the medieval University of Lleida), Vilars (an Iron Age settlement interactive system applied to the management of the archaeological registry), the gentleman and the chess (which proposes a trip in time and space around pieces of a 10th century chess), or the museum project of the diocesan and regional museum of Lleida [Fité 93].

The key to direct manipulation design is to create a visual representation of the "world of action" that includes selectable displays of the objects and actions of interest. Then with pointing, zooming, and panning the user can rapidly perform operations, see the results immediately and reverse operations if necessary [Schneiderman 97].
Although this style is suitable for many fields, will tend to be complemented or even replaced by other paradigms in a near future due to the great spreading of the computer use and its incorporation to all every day activities in which several users not necessarily skilled in the use of computers can be involved.
The interaction techniques must be adapted and specialized to make those activities easier without supposing a substantial change of attitude to that user not familiarized with the use of the computer.
The essence of new paradigms lies in transfering computation, so far focused in the desktop computer, to the real world so that information of any movement or action of the user in its normal activity can be captured and extracted to have constant knowledge of the user's situations, in order to help him if necessary.
The interactive area is no longer restricted to the screen. Now, we will talk about "interactive space", in which the inanimate objects of daily life that remain passive and static become active systems that react and participate in the scene, being even useful and efficient, since they are conscious of what surrounds them.
We start to percive a world where the borders between both animated (in an interaction sense) and inanimate objects are less and less noticeable, and the objects that surround us behave like useful assistant equipment. The interaction stops being an explicit activity to be expressly accomplished, to become an activity that, without express indication, takes place in a implicit way, taking in consideration data like the position and the characteristics of the user.
Ubiquitous computing enhances computer use by making many computers available throughout the physical environment, while making them effectively invisible to the user [Weiser 93].

Recent advances in mobile telephony and wireless computation have broaden the possibilities of the ubiquitous computation. 3G mobiles offers mobility without no bounds and its main goal is to make life easier in any task activity. This step obeys to the necessities of the consumer, offering the possibility of acceding to any information from any point of the world, without being plugged.
UMTS technology (Universal Mobile Telecommunication System) will lead the mobile communications towards the new society of the information. It will give access to the next generation of services based on information. The new cellulars will work like multimedia platforms suitable for the transmission of voice, data and images.

We propose to apply the technology considered here for the diffusion and management of the natural and cultural heritage of the Montsec.

The mountains range of the Montsec are situated in the western sector of the Catalan PrePyrenees, with a total surface of 506.65 Km^2. It is a place of great geological, historical, paleontological and landscape wealth that makes up a true natural laboratory very valued by the specialists. We like to call the fulfilment of such a circumstance with the term workbench. It forms an indivisible natural unit impossible to understand without the global study of all its elements. For that reason the project is considered like a museographical proposal, considering this natural spot as a museum environment, and under the outlook of the "ecomuseum" – a concept that tends to the notion of integral heritage [Hudson 90].

It is pointless to say that all the cultural and natural heritage of the Montsec needs a policy of intervention, on the part of the public administration and institutions, to manage the preservation of all its wealth.
For this reason, in 1988 arose the initiative to create a natural park in that spot, preparing a memory for such aim [AA.VV. 88].
In line to this and in an independent way, in 1998 another different initiative came also up impelled by the Joan Oró foundation. It is the Cosmoparc project which involves the construction of an atronomical observatory in the Montsec, due to its special conditions of celestial visibility.

A multimedia information system and the suitable architecture for a interface agent, which act as a guide in the system, are available at present. This material will be integrated into a ubiquitous computation system with wireless devices. In that case, this kind of devices will be 3G mobile telephones. It will be possible to count, therefore, with all the possibilities of a desktop computer. The difference lies in that the computing will be dispersed inside the environment, in a dynamic way, instead of being focused in an only point. All of that counting with speeds even upper to the ones we are used to.

The rest of the document is divided in four more sections. Section 2 introduces the interaction styles in which our system is based. Starting from the direct manipulation, amply known and which is the departure style to be improved or supplanted, two new alternatives are defined: the indirect management and the ubiquitous computation. In fact, both of them complement each other. Next, in section 3, the new technologies of mobile telephony are presented, giving a prospecting of future.
In section 4 the involved computing material is detailed, either the available at present information system, or the one put forward to integrate the former in the own environment. The ensemble of all the components specified in that section makes up the interactive model we present.
The paper ends with the conclusion and the bibliographical references sections.

2. TOWARDS NEW PARADIGMS OF INTERACTION

The direct manipulation interfaces present a visual representation of physical or conceptual objects and allow the user to execute actions on them to change their state, which appears reflected in the interface. There is a one by one relation between the actions explicitly invoked by the user and such changes [Schneiderman 97].
In this style of interaction the user must make explicit all the tasks and control all the events, which supposes much effort to him. This way of working must evolve, because it presents important limitations. New methodologies are required to make the interaction of the user with the application easier. It will not be possible to add more functionalities to the programs if we keep the one by one correspondence between the actions and the capacities of the interface.
Another aspect is the usability.
The usability, as it is defined by Dix in [Dix 98] is oriented, from our point of view, to the direct manipulation paradigm. So that, it has to be redefined to be adapted to the ubiquitous computing paradigm.
In their definition we can find attributes such as the synthesizability (the design of previous operations in present, necessary due to the limitation of the working memory [Card 83],

which tells us where the user is in the navigation diagram). This task will not be necessary for the ubiquitous computation and indirect interaction, since part of this navigation is solved in the context itself, taking part of the multi-interaction.

The indirect management uses the metaphor of the personal assistant or agent who collaborates with the user in the same scope of work, obtaining so cooperative environment in which both communicate, control events and make tasks in parallel, that is, autonomously, without all the responsibility to direct the interaction falling on the user [Maes 94].
In this type of interaction the objects of the direct manipulation interface can become affected, although not necessarily following a relation one by one according to the user's actions. In the same way, a single entry of the user can cause a series of actions on the part of the agent.

The introduction of the agent in an interactive multimedia application supposes a evolution in the possibilities of interaction of the user with the application that will allow to reduce the effort necessary to obtain the required information. Our aim is to obtain a simpler interaction [Lieberman 97].
The agent, who will have a knowledge base with all the information regarding the application, will be a suitable expert to take part in this type of application. He will answer the user's direct questions (for instance, to supply a route of interest), show his moods and will be in contact with the application to display the user the information properly classified according to his or her interests.
Regarding the communication between the user and the agent, it is planned to use the voice recognition.

In 1991 Mark Weiser (Xerox PARC) showed a new interaction paradigm publishing an paper about his view on the Ubiquitous Computation [Weiser 91].
Ubiquitous computing is roughly the opposite of virtual reality. Where virtual reality puts people inside a computer-generated world, ubiquitous computing forces the computer to live out here in the world with people. Virtual reality is primarily a horse power problem; ubiquitous computing is a very difficult integration of human factors, computer science, engineering, and social sciences. Alan Kay of Apple calls this "Third Paradigm" computing [Weiser 96].
Ubiquitous computation pretends to enlarge the computational capacity to the user's environment letting information capacity to be found anywhere in form of small and very diverse devices (appliances of information [Norman 98]) that allow interactions of very little difficulty, connected in the net to information servers. The design and location of these devices must be specially devised for the involved task. The computation, therefore, is moved from an only point to be diluted in the environment. The computer is pushed into the background, trying to be as transparent as possible to the user. This idea is usually related to the term "omnipresence" of the computation [Norman 98].
The ubiquitous computation paradigm is inspired on the constant access to information and the large computing capacities [Abowd 00].
In the view of the variety of current devices -active badges, marks, WAPs palmtops, tablets, whiteboards, among others-, we can say that the vision of Weiser has become a technological reality. Thus, today we can talk about environments where people do not interact with computers, but operate coherently in an integrated setting that incorporates computers and interaction devices of all sizes and kinds. Recent advances in wireless communication and ubiquitous computing have further extended the ubiquitous computing environment to anywhere, anyone, and any time.

Advances in hardware, though, are not sufficient to bring about ubiquitous computing (as we have always known). We cannot simply adapt existing software environments, which have evolved for decades to support the conventional one-person, one-display, one-computer setting (whether desktop, laptop, or PDA). The problem, then, is to create a hardware/software environment that supports multi-person, multi-device, multi-location work in an integrated way, building on existing software technologies while providing coherence for the environment as a whole. This requires both system integration, so that all the devices can interoperate, and interaction integration [Winograd 97].

3. THE FUTURE TELEPHONES

WAP stands for Wireless Application Protocol. With this group of specifications it is tried to give access to the Internet contents from a mobile telephone. The protocol is based on XML and IP technology, being their specific language the WML [Nokia 00b]. As it is conceived to be used on mobile telephones, the WAP protocol is based on small screens and navigation without keyboard. This is one of the aspects that makes WAP pages different from the WEB ones, as in WAP pages everything has to be simpler and smaller and the contents have to be in text mode.
The Nokia 7110, with a total support of WAP [Nokia 00a], is the first model that has been presented and commercialized. The micronavigator available can accede to WAP services of news, stock market, purchase of entrances, etc, without excessive multimedia parade, since the reception speed is only of 9.6 Kbs, limit marked in the GSM system through which the information is sent and received.
The third generation of telephones will break these barriers, redefining the way Internet is used. The new UMTS (Universal Mobile Telecommunication System) telephony has a greater amplitude of band than the present GSM system for the data transmission, allowing the reproduction of video and sound of high quality in the receiver.

Concretely, UMTS system establishes a communication channel of up to 2 Mbps, a speed 210 times upper to the current GSM, being guaranteed the quality of the transmissions.
This increase in the transference speed of data, along with the miniaturezation and integration of new electronic components in the terminals (the colour LCD screen or the small digital cameras) will turn to mobile telephone in a much more essential and modern tool, offering lots of uses of the future mobile: Internet access, telemetry and financial services, electronic commerce, communication, videoconference, multimedia navigation, IP telephony, virtual telephones, etc. These telephones will be similar to a small pocket computers since they will also incorporate multiple functions of agenda and management.

Furthermore, UMTS will become the universal system for the broadband mobile telecommunications, avoiding the necessity of changing the terminal anytime a border is crossed.

Both Nokia and Ericsson are working in the development and implantation of UMTS network at a world-wide level, but several intermediate technologies such as the Bluetooth technology, the GRPS (General Packet Radio System) and the HSCD, among others, will be used before the 3G arrives. This technologies will act as herald of the 3G.
It will not be long before these technologies get here.

4. DESCRIPTION OF THE INTERACTIVE MODEL

The first step to carry out the action proposals mentioned in the introducing section – natural park and cosmological park, along with the one associated to the concept of ecomuseum[1] – has been the production of a multimedia material entitled "The memory of the Montsec" which tries to offer an overview of the hereditary values of the area in a divulging way, and unimpaired of its scientific values.

This material is made up as the digital scale model of the ecomuseum, and represents a first approach for the achievement of the objectives, which consist of assembling, conserving and divulging this collection of cultural and natural real state.

Next, in section 4.1., we state the already available multimedia material. Section 4.2., which explains the proposed ubiquitous environment, and section 4.3., which mentions other computing possibilities to complement the assimilation of the contents, share the aim of presenting the overall interactive model with some details.

4.1. The Memory of the Montsec

The Memory of the Montsec gathers cross-disciplinary information on many fields: geology (from the Triasic period to its present disposition), biology (several heterogeneous ecosystems, its flora and fauna), history (from prehistoric time to the modern age), and geography of the Montsec.
Diverse multimedia material has been elaborated for this: videotapes in 3D, diverse animations, architectural and paleolandscape reconstructions, as well as numerous images.
Almost half a hundred routes recreated with more than a thousand images, which guide us through places of greater tourist, ecological, hereditary and gastronomic interest are introduced crossing step by step the geography of the Montsec.
Navigation enables constant connections among the four major fields treated through hyperlinks. Over a thousand definitions, many of them illustrated, are included, which are accessible by direct consulting on the text or by means of an alphabetical index.
The interface allows a flexible navigation either offering different types of access to the information, from the most general to the most particular, or acceding directly to more specific points.
An interface agent, whose purpose consist of helping the user in the search for more concretely requested information, is being also developed. This information will be adapted to the user's personality and knowledge by means of the historical registry of the aspects already looked up. The agent has been equipped with an anthropomorphic visual representation, according to its characterizetion (mainly its nature and potentialities, which make up its personality). This constitutes a metaphor with the theatre character, which allow to simplify the complexity of the human character, as it is pointed in [Laurel 93].

[1] We understand by ecomuseum an institution with flexible management formulas that tends to the notion of integral heritage either the natural component (geological, zoological and botanical resources) or the cultural component (artistical and architectural wealth group) [Abella 95]. This conception goes byond the traditional identification of the museum like a mere container of movable objects. Examples of those are the archaeological parks of museum nature.

The architecture we propose has been designed so that the agent can receive explicit tasks described in a challenging way, and can carry out its performance starting from a full knowledge on the world it lives in.
It is a cooperative architecture whose main aim is to supply the necessary mechanisms to the right communication between the application and the agent. Our intend is to manage that all the actions made by the user inside the environment can be direct or indirectly known and processed by the agent. According to Lieberman, every application that fulfils these characteristics must receive the label of controllable application.
Other terms defined by Lieberman are the programmable application (when the application can be manipulated by the agent), and the examinable application (when it is possible to revise periodically the data structures data trying to infer the actions in progress) [Lieberman 98].
Today we are working in the agent integration in the application following Lieberman's guidelines.
On the other hand, the knowledge on the environment is stored in a knowledge base, which constitutes the key element of our architecture. This piece will provide the necessary information to the agent concerning to the application.
In order to exploit the stored knowledge we use an inference motor which has different mechanisms to infer results. One of them, the compensatory filtrate, acts considering the agent's characteristic features.

The profits from a practical point of view and about its applicability are summarized in:

- To present an integral heritage: those that compose the natural heritage and those that integrate the cultural heritage.
- To assemble a sparse heritage located outside the territory and to restitute it virtually to the origin place. With that it is possible to recreate a lost historical reality.
- To promote the tourist offer of cultural or "green" type to obtain a tourism of quality, sensitized with the heritage.

Its functionalities are summarized saying that this material make easier the consulting and subsequent understanding, with a didactic capacity upper to a conventional visit of the environment. Concretely, the multimedia product lets us:

- To arrange the visits and circuits through the historical itineraries (for example, the repopulation) or monographics (for example the route of the castles), already virtually elaborated, offering a useful guide throughout any itinerary.
- To interrelate the historical-artistic heritage with the natural one, so that the user has crossed references according to coincident areas of influence.

We will be able to carried out all this possibilities, not only executing the application from home, as mere consulting, but also solving the same questions in situ, as a visitor of the area that interacts with the application and the environment at the same time.

4.2. Description of the proposed ubiquitous environment

We propose a novel interactive model, consisting of 3G mobile telephony devices, interconnected by the GSM system, with access to the available multimedia material, as an itinerant and interactive audio-visual through the route by the Montsec area.

This initiative will equip our system with all the characteristics we had set out. On the one hand, it will reinfoce the interactivity degree since it incorporates a new level of interaction to add to those already available. For this reason we label our system multi-interactive.
Therefore, to the interaction among user, application and interface agent we can add the interaction that is settled down between the user and the environment. According to the user's geographic positioning the application makes a search process of the information related to the sector involved. This information is automatically shown to the user through the available terminal. We can so assume our system as an active and dynamic entity [Brogni 00].
In the selection of the information to show to the user it also gets involved another component consisting of: the previously made by the user visit and activity history and the user's profile (personality, concern, interests and basic features like age and level of studies, among others).
This information is stored in the system and, like the interface agent in the indirect interaction, will be inferred through an inference motor adapted to our purpose. In fact, the possibility of reminding the user the previously visited elements, which have connection with the piece or element subject to study, will benefit, without doubt, its understanding. Our intend is to avoid starting from scratch anytime and, therefore, to reduce the necessary cognitive effort. It will be possible to shape the final presentation of the information to the user.

Moreover, our model fulfils the ubiquity principles.
We can make sure that computation is everywhere. In fact, an exhaustive monitoring of the user (from a geographic, historical – a previous visit and activity history – and personality point of view) is made. The knowledge of the previously made by the user actions contributes to the presentation of the information offered to him. This characteristic also fulfils the ubiquity principles.
The interactive zone is not limited to a screen since the application, in accordance with parameters such as the geographic positioning, answers showing automatically the information related to the visited area. So we can implant a totally interactive space in the Montsec area.
The interaction stops being an explicit activity, that has to be exercised specifically, to become an activity that, without express instruction, takes place in an implicit form, taking in consideration data like the user's position and characteristics.
We are able to extend the computational capacity to the user's environment as the ubiquitous computation was defined in [Weiser 91].
Recent advances in wireless communication have allowed to extend the ubiquitous computation viability letting us create a multi-person, multi-device, multi-location and multi-interactive enviroments.

In short, the model proposed in this paper offers the characteristics of a multi-interactive, multimodal (ubiquitous computation and indirect interaction integration, without forgetting the presence of the direct manipulation) and, of course, mobile system providing the user, therefore, all this potential throughout its itinerary. To sum up, it is obtained the itinerant consulting and interactive guide support that we propose for the broadcasting and promotion of the Montsec area.

This technology – of a reasonable economic cost - applied to museographical science constitutes an innovation without precedents, comparable to all types of museums.

The visitor will be able to rent the mobile telephony devices in the own museum welcome centre.

4.3. Other computing components

All work of art needs to make explicit an information in order to make easier the understanding to nonformed visitors. In this sense we put forward to locate interactive kiosks in order to complement the information of the park. This can be offered as a formation material like games, interactive activities, etc., that let us to reinforce the acquired knowledge.

Finally, it will be able to complement the former activities with those from other museums or thematic materials through external links, in order to intensify some specific aspects.

5. CONCLUSIONS

Today, technological advances produce constant and substantial changes. Proof of it is that the new interaction paradigms will extend the accessibility to the computation to users of diverse ages, ability levels, cognitive styles, languages and sensorial and motor capacities, since it offers an expressive, transparent, efficient, robust and, mainly, flexible style of interaction. This will overcome the barrier that the direct manipulation had established.

Our effort is aimed at a geographic space with an important natural and cultural heritage. Three different proposals of intervention have been elaborated – natural park, cosmological park and ecomuseum -, all of them interrelated and compatible to each other.
Starting from this reality, our intend is to create a project oriented to the preservation, management, diffusion and promotion of the real state and resources of the area through the use of the new technologies.

With the integration of the 3G mobile terminals and other interactive components to our multimedia information system it will be able to build a multimodal environment, to which we have also labelled multi-interactive. The reason of using this term is that the interactivity degree of the application has been increased in relation to its initial product, letting our system act as an active and dynamic entity, which reacts and participates in the scene conscious of its environment. We can so extend the computational capacity to the user's environment, allowing to solve part of the interaction in an implicit way, and turning the Montsec area into an interactive space.
The previously made by the user visits an activities repository, along with the information adapted to its specific profile, make the contents of interest accessible, reducing the necessary congitive effort.

The final product we propose will make easier to a great extent the consulting and interactive guide of the park, as mentioned before, and will constitute an itinerant tool of great value for the attainment of the proposed objectives.

We are aware that this ambitious macroproject will need great economic and human efforts. Nevertheless, we also trust this proposal will definitely articulate the management, protection and dynamism of all the hereditary elements that form the exceptional supraregion of the Montsec, through the cross-disciplinary approach of researchers, specialists and technicians

from different fields, and bringing the technological novelties considered throughout the paper.

6. REFERENCES

[AA.VV. 88] AA.VV., Estudi de delimitació dels espais naturals a protegir del Montsec. Memòria, Generalitat de Catalunya, Territorial politics and public works Department, 1988.

[Abella 95] J. Abella, El paper del Museu en la gestió cultural d'un territori. L'experiència de l'ecomuseu de les Valls d'Àneu, Revista Cultural de l'Urgell, Nº 8, 1995, pp. 189-195.

[Abowd 00] G. Abowd, E. D. Mynatt, Charting past, preseent and future research in ubiquitous computing, ACM Transactions on Computer-Human Interaction. Vol. 7, No. 1, March 2000, pp. 29-58.

[Brogni 00] A. Brogni, An interactive system for the presentation of a virtual egyptian flute in a real museum, Virtual reality in archaeology. Archaeopress, april 2000.

[Card83] S. Card, T. Moran, A. Newell, The psycology of Human-Computer Interaction, Lawrence Erlbaum Assoc, 1983.

[Dix98] A. Dix, J. Finlay, G. Abowd, R. Beale, Human-Computer Interaction, Prentince Hall (2ª ed.), 1998.

[Fité 93] F. Fité, Museu Diocesà de Lleida 1893-1993, Catàleg de l'exposició Pulchra, Pagès editors, 1993, pp. 54-55.

[Hudson 90] K. Hudson, Museums of Influence. Cambridge, 1990.

[Laurel 93] B. Laurel, Computers as theatre, Addison-Wesley Publishing Company, 1993.

[Lieberman 97] H. Lieberman, Autonomous interface agent, CHI'97, Atlanta, 1997.

[Lieberman 98] H. Lieberman, Integrating user interface agents with conventional applications, Intelligent user interfaces , 1998, pp. 39-46.

[Maes 94] P. Maes, Agentes that reduce work and information overload, Communications of the ACM Vol 37. Nº 7, july 1994.

[Norman 98] D. A. Norman, The invisible computer, The MIT Press, Cambridge Massachusets, 1998.

[Nokia 00 a] Nokia, 2000, http://www.nokia.com.

[Nokia 00 b] Nokia, 2000, http://www.nokia.com/wap/wap_excite_search.html

[Schneiderman 97] B. Schneiderman, Designing the User Interface, Addison and Wesley, chapters 3,4,5, 1997.

[WAP http://www.nokia.com/wap/wap_excite_search.html

[Weiser 91] M. Weiser, The computer for the twenty-first century, Scientific American, 1993, pp. 94-104.

[Weiser 91] M. Weiser, Some computer Science issues in ubiquitous computing, Communications of the ACM, Vol. 36, No. 7, July 1993.

[Weiser 96] M. Weiser, Ubiquitous computing, http://www.ubiq.com/hypertext/weiser/UbiHome.html

[Winograd 97] T. Winograd, Interaction design for ubiquitous computing, Beyond Calculation: The Next Fifty Years of Computing, Springer-Verlag, 1997, 149-162, http://hci.stanford.edu/~winograd/acm97.html