Adapting the museum: a non-intrusive user modeling approach.

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Abstract. Technology within museums can improve human cognition by supporting the experiential mode more than the analitic one. In order to exploit this powerful concept our approach is based on empathy and "mimesis". This work explores issues of audio-guide adaptivity based on physical navigation and information browsing. The goal is to design an augmented reality system that is able to transform the museum into an intelligent environment, which can integrate individual needs and collective behaviors. Physical movements within the museum are used to classify visitors. This dynamic classification utilizes a non-intrusive user modeling approach, wherein the museum acts as an interface.

1 Introduction.

The aim of this project is to mediate a museum visit in an experiential and empathic mode (Norman, 1993). The mediation aim to be dynamically personalized and used by the system as a base of learning in order to adapt itself to each new visitor. The main hypothesis is that the spatial movements of the visitors inside the rooms are an important source of information for developing an implicit user modeling approach. Anticipating the physical behavior that visitors will adopt in each consecutive room and integrating this data with the information regarding the individual's preferences, the system can adapt an engaging and personalized visit. The complexity of this approach has been resolved in our prototype by adopting an hybrid architecture, using a socio-semiotic classification implemented by means of artificial neural networks integrated with a self-organizing algorithm. This dynamic user modeling generates an adaptive audio path from a hypertext related to each work of art. An evaluation phase, based on the user-centered approach, has been carried out in the HIPS project[1], which provides museum visitors with PDAs offering audio headphones, motion tracking and wireless data transmission.

2 Non-intrusive user modeling.

Detailed field surveys have shown how visitors tend to navigate an exposition space in homogeneous modes. Adopting a socio-semiotic perspective, Veron & Lavasseur (Veron et al.,

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1983) classify visitors in four main categories: ant (long visit, sequential, complete, physically next to works of art); butterfly (half-term duration, selective, less sequential); fish (quick visit, superficial, away from the work of art); grasshopper (short visit, with a few stops, non-sequential). From the field studies phase, conducted by means of non-partecipative observation, it has emerged how the modalities mentioned above are also found inside the "Museo Civico" of Siena, which is an historical building adapted to museum. The detection of the physical behavior of visitors within a museum, taking into account the time, movements and trajectory, can facilitate the acoustic mediation generated by the system. The variables that have to be analyzed to carry out this kind of classification are difficult to account for using static and discrete models. A prototype has been developed in which physical user modeling is proposed, managed by a recurrent neural network (Giles et al. 1994) based on concrete examples from field observation, following the categories proposed by Veron & Levasseur. The variables considered in the first prototype include: the organization of physical space in cells, the time spent in each cell, and the association of time values and i.d. number of the cells. Some of the museum's artworks have a larger affordance, because of their importance, dimension or position. This aspect is carried out normalizing the array, which represents the time spent in the field of action of an artwork, by a prominence factor.

2.1 Physical space and collective tracks.

Structural and organizational similarities between rooms simplify the process of monitoring visitors' behavior as they pass from room to room. In the prototype an initial clustering of the rooms based on the topological parameters is proposed. The subsequent subjects navigating the rooms will dynamically improve this classification. To attain this goal a module of the prototype consists of a self-organization algorithm (Learning Vector Quantization) (Kohonen et al., 1992), which calculates an 11 dimensional vector. The first 7 elements concern the topological and general parameters of the room (dimension, number and period of the work of arts, prominence) and the other 4 update the clustering, calculating in a dynamic way the statistics of the physical user model's relation to the rooms. This aspect enables the physical user model to anticipate visitor behavior, with respect to the characteristics of the museum, and rooms' navigation statistics.

2.2 Audio adaptive presentation and collaborative machine learning.

An experimental set is designed to investigate the conformity between the navigation of the physical space and the information space within a museum. In the prototype (Fig.1), an auditory presentation not supported by a visual display is provided to subjects, in order to explore the possibility of expanding the interaction with the environment. The descriptions of the artworks have been segmented in small blocks, each of them labeled with one of four possible topics (generalist, historical, anecdotal, and artistic). In the prototype the hypertext corresponding to each description has been represented in a matrix of nodes and links between nodes. Each link is weighted by a value. The blocks have been organized in a hypertextual structure, setting links between them on the basis of logical relationships. The information space is managed by a specific learning algorithm based on the deposit of the tracks of each visit. At the entry of the action field of an artwork, the system receives the physical user model type to which the user belongs, integrated with his topic preferences statistically updated at the end of each artwork hypertext browsing. Each user type is

assigned a different threshold value for generating the audio path. The learning algorithm updates the weights over the connections according to visitors' reactions to the adaptive path proposed for each artwork.

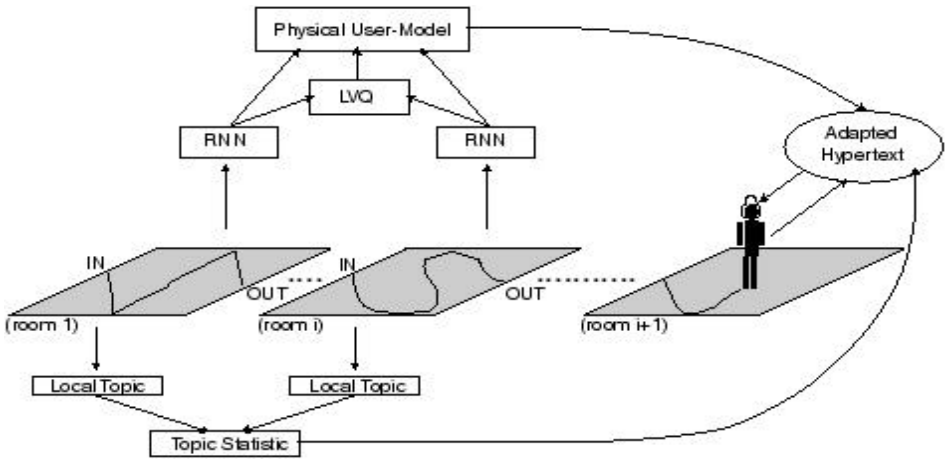

Figure 1. Prototype design

3 Prototype evaluation.

Iterative design guides the development steps. Using a user-centered approach each module of the prototype has been tested in the real context inside the museum and in reconstructed scenarios. The results shows how the subjects' reactions to the proposed path change critically taking into account (or not) the right classification of the subject's strategies for browsing the physical space: the amount of information skipping, and of explicit requests for more information significantly increase if the physical user-model has been altered.

References

Giles C. L., Khun G.M. and Williams R.J. (1994) "Special Issues on Dynamic Recurrent Neural Networks", *IEEE Trans. on Neural Networks*, 5,2.

Norman D. A. (1993) *Things that make us smart*. Reading, MA: Addison-Wesley.

Kohonen T.,Kangas J., Laaksonen J. and Torkkola K. (1992), "LVQ_PAK: A program package for the correct application of Learning Vector Quantization algorithms" *Proc. IJCNN'92, Int. Joint Conf. on Neural Networks*, Vol. I, pp. 725-730, IEEE Service Center.

Veron E. and Levasseur M. (1983) *Ethnographie de l'exposition*, Paris: Bibliothèque Publique d'Information, Centre Georges Pompidou.