Onna project: a natural interaction installation and mobile solution for cultural heritage

Gianpaolo D'Amico; Alberto Del Bimbo; Andrea Ferracani; Lea Landucci; Daniele Pezzatini
Università degli Studi di Firenze, MICC, Media Integration and Communication Center, Florence, Italy

1. Introduction

In the last years art curators have become more and more aware of the need to provide visitors with an augmented experience while visiting exhibitions and museums. New models of art installations have been proposed via the adoption of advanced digital technologies, like multimedia environments, touchscreen systems and mobile applications. In this paper we present Onna - Past, Present and Future, a multimedia installation and a mobile solution designed and implemented for the museum of Onna, a small town close to l'Aquila (Italy), which was completely destroyed during the earthquake in 2009.
The whole community of Onna have been working since many years not only to physically reconstruct the town, but also to give local citizens and visitors a clear and strong message of hope for the future. To address this issue the non-profit organization Onna Onlus has built a museum in which the life of Onna before the terrible earthquake is described and presented to visitors. A special area of the museum, called Infobox, is equipped with multimedia technologies and interactive systems with the aim to properly show the past events and raise awareness of the efforts invested in the work of reconstruction. In this environment visitors of the museum can interact with a natural interface system and then discover information about the history of the earthquake via digital content. A large collection of information is showed in audio/video format to tell the stories of these last years: interviews with people who directly lived those dramatic moments, images of Onna before and after the disaster, maps visualizing the altered geography of some places in the area all around the town. While interacting with the system, the activity of each visitor is recorded by a profiling system, which extracts a dedicated profile of interest. At the end of the visit of the Infobox an additional experience is offered to the visitors of the 'real' town using their mobile devices. They have the chance to activate a dedicated application properly installed on their smartphone, which communicates via Internet to the indoor profiling system and shows suggested personalized and geo-located in-depth information based on the actions performed during the session with the interactive exhibit.
This paper is organized as follows: in the next section we explain the indoor system in detail; in section 3 we describe the solution implemented for the outdoor experience. Finally, in section 4 we discuss conclusions of our work.

2. The indoor system

The indoor system consists of an immersive space composed of a natural interaction system (fig.1), which allows visitors to interact with multimedia contents, and a user profiling system, which records the actions of visitors in order to create a bag of information to be used by the outdoor system through the

Fig.1- the installation is composed of a central interactive rear-projected screen and two lateral screens used for displaying non-interactive multimedia contents

mobile application. Currently the user profiling system is in an experimental state and is being tested in order to be installed soon in the Infobox.

2.1. Natural interaction system

The aim of the natural interaction system is to show the condition of the town during the days immediately after the earthquake, allowing users to touch some of the destroyed areas to reconstruct their status before the tragedy and to watch related multimedia contributions. The idea is to arouse an emotional drive in the visitor and to make everyone feel part of the town reconstruction, which is still in an initial state: a small touching gesture that can metaphorically restore life from rubble.

The system is composed of a central large display made with a slab of opaque plexiglass and a short throw projector which illuminates it from behind. At the two sides of the main screen, are positioned two opaque panels illuminated by two projectors installed in their upper part, in order to have two lateral displays. A stereoscopic camera placed behind the central display captures the interaction in the front area in real-time, recognizing gestures and then processing them through a Computer Vision module based on diffused illumination technique [Baraldi, S., Del Bimbo, A., Landucci, L., Torpei, N., 2009]. In order to make vision sensing reliable and robust to light changes in the environment, the cameras works in the near infrared spectrum and the scene is illuminated with NIR lights.

The natural interface presents the post-earthquake map of Onna which visualizes pre-earthquake areas when the hands of the visitor are close to the surface of the main screen (fig.2). For each selected zone the interface shows a

Fig.2: the user interface of the installation presents an aerial view of the town after the earthquake. Visitors can move the hand close to a zone of the town and visualize the pre-earthquake status. For each selected zone a carousel of images is shown, which can be activated with the same gesture in order to start the playing of video stories on the lateral screens

carousel of images as thumbnails, which can be activated via gestures by the visitor in order to start the play of multimedia contents on the lateral displays. These contents consist of videos and texts reporting the history of the town through testimonies, interviews and institutional events.

2.2. User profiling system

The system features a profiling layer that fulfills two main goals through specific modules: 1) to identify where the user is located with respect to the two areas that comprise the interactive environment (with an experimental position detection module, not yet used in the current installation), 2) to record the interactive session for each detected user (natural interaction module) in order to build a user profile of interest. This profile of interest is used for content filtering and interests targeting in the mobile application developed as part of the outdoor system.

The position detection module exploits RFID technology. Each visitor of the Infobox will be equipped with an RFID passive tag (two solution were experimented: a badge attached to a collar around the neck or mounted horizontally on headphones). Two antennas positioned at the sides of the installation detect if users are interacting with the right or the left area of the interface through an SVM classifier. The module estimates the distance reasoning on data readings from the antennas and uses as primary input the Received Signal Strength Indicator (RSSI) [J. Zhao, Y. Zhang, and M. Ye., 2006].

The detection of the users position in front of the natural interface is used to associate their identities to the interactive sessions. Data of the interactions are extracted through collaborative filtering techniques [Resnick, P., Iacovou,

N., Suchak, M., Bergstrom, P., and Riedl, J., 1994]. These techniques are essential for the filtering and customization of content in multimedia systems. They work through building a database of user preferences for content items. User preferences are exploited to identify other users with similar behavior in a user based recommendation scenario, or to compute relationships between pairs of items through a co-occurence matrix in an item based recommendation system. In this way new items can be recommended to the current user as he probably will be interested. In the Onna project the profiling module utilizes an hybrid CF in the sense that the module combines a memory based approach, which uses an item based recommender, with a model based one that analyzes the common features among the contents selected by a visitor. The hybrid CF doesn't use explicit ratings data to compute similarity between items but the data are implicitly inferred by the system observing user behaviors during their interactive sessions with the user interface.
User profiles computed by the hybrid CF module are then used by the outdoor system in the process of content generation to recommend personalized multimedia content and real-world points of interest to people using the mobile application.

3. The outdoor system

In order to enrich the visitors experience during their outdoor exploration of the town, a cross-platform mobile application was developed with the aim to suggest points of interest and offer additional related multimedia contents.
The application proposes some real-world itineraries and geo-localized points of interest, suggesting some itineraries based on the user's interest profile. When a visitor approaches one of the proposed geolocalized point of interest, the mobile application notifies it and provides multimedia contents and some associated in-depth contents. In this way we offer visitors multi-modal ways to enrich their experience.

3.1. Mobile application

A location-based service paradigm [S. Wang, J. Mic and K. Y. Byung., 2008] was exploited, using geographical information from mobile devices via GPS. The GPS module of the modern smartphones [Y. Zhao, 2002] allows the application to detect the user's latitude and longitude with a certain accuracy, that may change due to the device capabilities or the strength of the signal received.
The app provides a collection of places inside Onna that can be visualized both as a list ordered by distance from the user or as a map (fig.3).
For each point of interest contained in the collection, users can browse a gallery of related multimedia contents, such as pictures, historical videos or interviews, and future plans of reconstruction.
Places are also organized in routes, that can be both pre-defined or dynamically generated by the recommendation module. Predefined routes have been created along with Onna Onlus in order to create thematic visits through the town. Personalized routes can also be generated exploiting the profiling layer, feature that has not yet been added in the real installation.

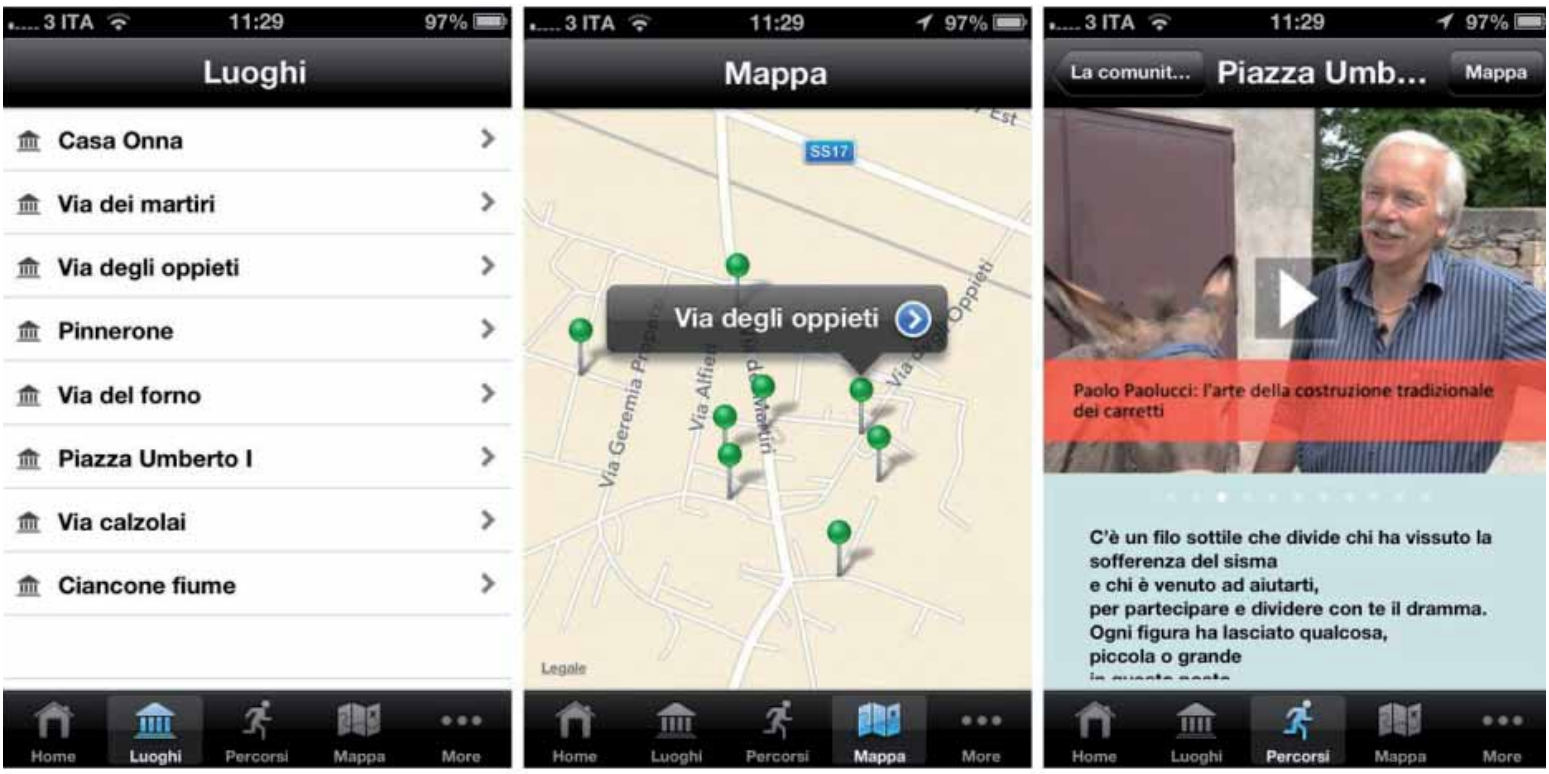

Fig.3 - The mobile application proposes a collection of points of interest displayed as list (on the left) or as a map (on the center). For each POI a gallery of multimedia contents is provided (on the right)

Users can associate their RFID-enabled ticket to the mobile app (e.g. using an unique ID). The application retrieves from a web server a list of geo-referenced points of interest based on the user profile. Then, using the Google Maps API direction service, a personalized walking itinerary is proposed to the user together with in-depth related multimedia content. In this way the system can use the interaction history of the user in order to create and suggest itineraries through the town.
The app was developed using the Titanium Appcelerator framework and the Javascript programming language, and can therefore be deployed for Apple iOS devices and for Android smartphones.

4. Conclusions

In this paper a proposal to enhance the experience of visitors in a museum environment was presented.
Our solution consists of an interactive installation based on a natural interaction paradigm, a system to estimate each visitor interest during the interaction with the installation and an outdoor system based on a mobile application. Thus a visitor can live a multisensory, cross-modal and multi-located experience discovering the history of a dramatic event which caused some years ago the devastation of the small town of Onna in Italy.
On April 6th 2013 the system was installed in the Infobox space in the new museum of Onna, at the presence of the mayor of L'Aquila and other institutional representatives.

Acknowledgements
The work project was developed in collaboration with Onna Onlus and RAI. The authors would like to thank Gabriele Corsinovi for his contribution to the development of the mobile application and Nikrooz Hosseini for the selection and organization of multimedia assets.

References
Baraldi S., Del Bimbo A., Landucci L., Torpei N., 2009, *Natural Interaction. Encyclopedia of Database System*, Springer.
Zhao J., Zhang Y., Ye M., 2006, *Research on the received signal strength indication location algorithm for rfid system*, in *Communications and Information Technologies*, 2006, ISCIT '06, International Symposium on, pages 881-885, 18 2006-sept. 2.
Resnick P., Iacovou N., Suchak M., Bergstrom P., Riedl J., 1994, *GroupLens: An Open Architecture for Collaborative Filtering of Netnews*, in Proceedings of CSCW '94, Chapel Hill, NC.
S. Wang, J. Mic, K. Y. Byung, 2008, *Location based services for mobiles: Technologies and standards*, in IEEE ICC.
Y. Zhao, jul 2002, *Standardization of mobile phone positioning for 3g systems*, «Communications Magazine», IEEE, 40(7): 108 –116.