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On the Use of Personal Information Spaces for Enhancing Visits to Archaeological parks: a Preliminary Study

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Abstract. Information and communication technologies have a great potential in increasing people awareness and appreciation of cultural heritage, and in particular, of archeology. In the last few years, we have been considering new, more valuable and engaging ways to visit archaeological sites. In this context, this paper illustrates a platform implementing a new composition paradigm allowing professional guides to extract contents from heterogeneous (personal or third-parties) sources, and compose Personal Information Spaces (PISs) that satisfy their situational information needs. The paper discusses how the created PISs can support the work of the guides in organizing and tackling the visits, and enhance the overall visitors' experience. A field study involving 2 professional guides and 28 visitors of an archeological park provides hints on the potential of the platform in bringing practical value to the involved stakeholders. It also provides useful insights for future work.

Keywords: Composition Paradigms, End-User Development, Cultural Heritage, Field Study

1 Introduction

Italy is one of the countries in the world with a rich patrimony of historical sites and cultural heritage. People are becoming increasingly aware that cultural heritage must be preserved and value-enhanced, acknowledging it as a way to help people constructing their cultural identities [1, 2]. Information and communication technologies have a great potential for getting to this goal.

Knowing the value of the multidisciplinary research in Human Computer Interaction (HCI), together with archeologists, history experts and teachers we have been investigating, in the last years, how novel technology can support a greater awareness and appreciation of archeology by different people, especially children. In particular, we have developed educational games to be played by group of school pupils during, or after, the visits they perform to archeological parks [3-6]. The aim is to make such visits, which are part of their school curriculum, more valuable and engaging. The games have been created through participatory design by setting up teams composed by different stakeholders, including archaeologists, school teachers, directors and staff representatives of archaeological parks, visitors, professional guides. The discussions with such stakeholders and various studies carried out in the field gave us the opportunity to analyze the work of professional guides and the behaviors of people of different ages, countries and cultural background visiting sites like museums and archaeological parks. We realized that the availability of various multimedia resources, which the guide could show during the visit an archeological park, could greatly increase the visitors' overall experience, helping them to reconstruct the life at ancient times starting from the remains currently in the park.

More recently, we have been working on the development of a platform implementing a new composition paradigm to allow end users, not necessarily experts of technologies, to extract contents from heterogeneous (personal or third-parties) sources, and compose Personal Information Spaces (PISs) that satisfy their situational information needs and can be ubiquitously executed on different devices. We started from a generic composition platform, which is flexible enough to be adopted in different contexts of use [7, 8], and we adapted it with respect to the requirements identified within the specific communities of users. This platform provides people with the means to integrate data, services and tools, enabling them to play an active role in solving their every-day problems, in accordance to the culture of participation [9] and to End-User Development approaches [10-13].

In this paper, we show how the PIS composition platform has been used to provide support to the work of professional guides when accompanying visitors to archaeological parks. We describe the different software solutions we have implemented to allow professional guides to create and use PISs through different devices.

We then report a field study performed in November 2012 to understand, in real conditions, potentials and limitations of the composition and use of PISs with the current prototypes (desktop, multi-touch display, tablet). The study involved 2 professional guides and 28 visitors of the archeological park of Egnathia, in Southern Italy. At this stage of the platform development, the study is primarily based on qualitative data. The analysis of the results provides indications about the practical value of the platform as well as useful insights for future work.

The paper is organized as follows. Section 2 motivates the use of PISs in the context of visits to archaeological parks. Section 3 illustrates our PIS composition approach and its main characteristics. Section 4 describes the software solutions for composing and using PISs we have implemented. Section 5 presents and discusses the field study. Section 6 briefly reports related works, and Section 7 concludes the paper.

2 PISs in the Context of Visits to Archaeological Parks

For several years we have been working in the context of archaeological parks, carrying out user studies and setting up participatory design teams that gave us the opportunity to identify, through the help of different stakeholders, requirements for new applications that could support people and enrich their experience at archeological parks [3-6]. Recently, we have performed a more systematic contextual enquiry [14], observing how several professional guides lead groups of tourists and school students of different age in the archaeological parks of the Apulia region, in Southern Italy. The aim was to identify more precisely how to support their work.

From the contextual enquiry, it emerged that guides could take great advantages from using personal information spaces offering access to important material to be used during their work. Interviews and focus groups involving guides, park staff and visitors allowed us to capture details on the overall visit organization. We found out that one of the main difficulties experienced by professional guides during guided visits is related to the effectiveness of their presentation when they want to provide hints to people to make them imagine the original aspect of the current (poor) remains and to recreate life as it was at ancient time. Explaining habits or daily activities of ancient civilizations is very challenging without the support of multimedia contents, e.g., 3D reconstructions of the original aspect of buildings, photos, sketches of ancient every-day life scenes, videos of excavation campaigns. In several circumstances, the guides highlighted the need to retrieve new content during the visits, with respect to what they selected beforehand, primarily to comply with specific visitors' questions.

We also realized that it is important to present such material *pervasively*, i.e., in different contexts of use and through different devices. Indeed, large interactive displays could guarantee an engaging presentation, but their availability is limited to indoor spaces (for not exposing them to the weather conditions) and to specific moments of the visit: for example, at the beginning of the visit in the hall of the museum associated to the park or in a room. The guides would instead use a mobile device, e.g., a tablet, in the park.

3 PIS Composition Platform

Based on the experience gained in the design of tools for the end-user composition of mashups [7, 8, 10] , we have defined a composition paradigm and a lightweight platform to support end users in the construction of personal and pervasive information spaces. Our approach allows a user to access resources offering heterogeneous contents, to compose such resources creating PISs supporting their specific needs, and to share such contents with other people. The access to the PIS may occur from multiple devices. The composition of such interactive spaces exploits a "lightweight" paradigm for resource integration, whose main characteristics are summarized in the following.

Intuitive visual mechanisms allow end users to easily integrate contents and compose PIS without any need to program or adopt complicated design notations. The current interaction paradigm is based on drag&drop of content items extracted from third-parties or personal data sources and moved onto pre-defined templates of the user interface. A composition environment (see the left part of Fig. 1), accessed for example through a desktop computer, a mobile device or a large multi-touch display, shows the contents retrieved by querying selected Web data sources registered into the platform, and allows the users to use such contents to fill-in *visual templates*, i.e., templates made available to the users to allow them to easily create the user interface of the PIS under construction. The example in Fig. 1 refers to the composition of a PIS on a map template, on which the user drags some of the elements s/he has retrieved, e.g., 3D reconstructions from Google Sketchup, photos from FlickR, videos from YouTube. The results of such a visual composition is the PIS represented as an XML-based schema; the user can store this PIS on the platform server and download it anytime and anywhere for its execution on different devices. The schema specifies the services included in the composition, the way they have to be queried based on the com-

position created by the user, and the way the retrieved contents have to be displayed through rendering elements of the visual template.

Lightweight execution environments allow the execution of the created PIS on different devices. The composition schema created on the basis of the user composition actions indeed constitutes a Platform Independent Model (PIM), which can be interpreted locally on a given device by means of a dedicated, lightweight runtime environment addressing the device native technology. The application code is then automatically generated and executed on the device, showing data dynamically extracted from the remote resources. In the example in Fig. 1 (look at the right part), the generated application shows on the user device a map with the content items added by the users.

The execution environment natively supports context-awareness. The execution environments on mobile devices include a *context monitor* able to interoperate with the device sensing modules (e.g., the GPS receiver), and exploits the context data captured at run-time to adapt the fruition of the application (e.g., filtering data related to the current position).

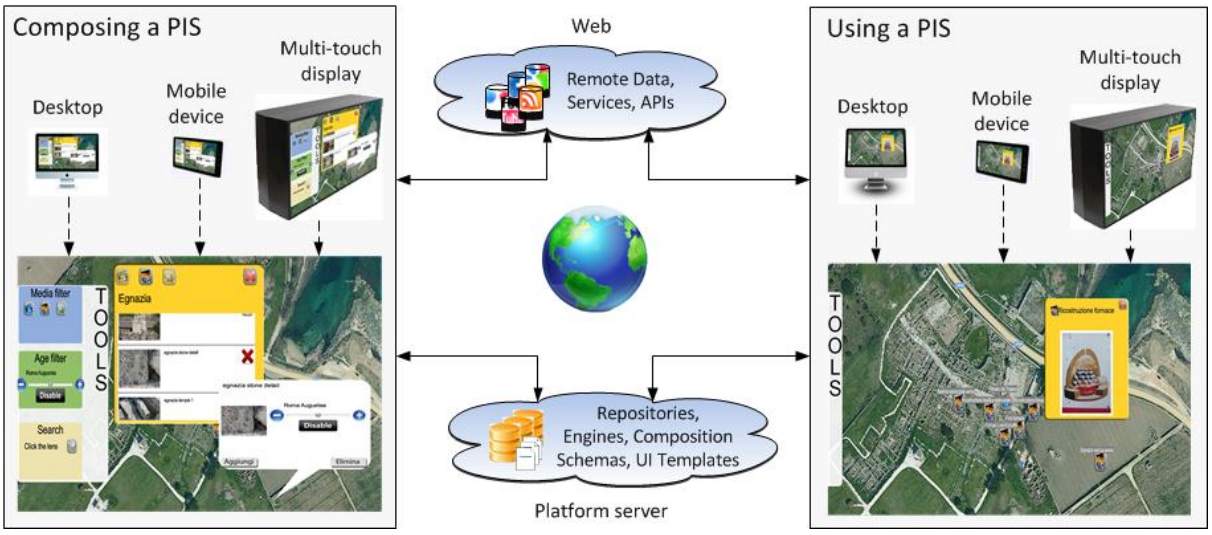

Fig. 1. A sketch of platform main elements and communication flows.

The platform is amenable to customizations to meet the requirements of specific usage domains. The composition paradigm illustrated above is not tied to any specific domain. Our platform is indeed open in its nature, being it conceived for the integration of heterogeneous services, based on different visual templates. This openness facilitates the customization of the platform with respect to the characteristics and needs of specific communities of end users. Customization, for example, occurs by selecting and registering into the platform services and data sources (public or private) that can provide content able to fulfill relevant user information needs. Service registration is kept simple, to allow even inexperienced users to add new services as they need them. Registration requires the user to input, by means of visual forms, the service URI and the value of some search keys to execute basic service queries.

New visual templates for data visualization can also be easily added, by instrumenting the design environment for the PIS composition based on the new templates, and by extending the execution environments with mechanisms

for the instantiation of the corresponding user interface. In our current version of the platform, we have implemented map-based, list-based and graphic-based templates.

It is worth noting that the schema generated by the PIS composition makes use of conceptual elements, called *visual renderers*, which are independent of the specific visual template chosen for the composition. Visual renderers are generic receptors of data that, based on the user composition choice, act as placeholders for data visualization during PIS execution. The PIS schema consists of a set of visual renderers, each one representing the integration of data items coming from different resources. The way visual renderers are displayed according to a given layout then depends on the visual template selected by the user at design time, which in turn implies a specific mapping between the visual renderers in the abstract model and the widgets in the concrete visualization layout. The addition of a new template basically requires the definition of a new visualization layout, and of the mapping between the abstract visual renderers and the concrete elements of the layout that will be used to instantiate the PIS user interface. The composition paradigms and the rule for schema generation remain unchanged.

Different from service registration, the definition of new visual templates necessarily requires the intervention of technicians (typically platform administrators). Nevertheless, this extra-effort is justified by the fact that the customization of visual templates introduces a level of specificity, in relation to specific domains, that is needed to increase the value of the platform with respect to the addressed end users. Some recent studies on composition approaches indeed shown that too general platforms are not used with satisfaction by users, who instead prefer paradigms customized with respect to their specific needs [15, 16].

In the next section, we describe how the approach and the platform for PIS composition have been applied to the context of visits to sites of cultural interest. Professional guides can access heterogeneous services offering relevant material, and collect and compose interesting content to be shown during the visit, within their personal Web-based workspace (the PIS) where the adopted visual template is a map-based visualization. The resulting composition can be then accessed on different devices, depending on the situational needs arising during the visit.

4 Software Environments for Composing and Using PISs

In order to allow professional guides of archeological parks to create and use PISs to support their work, we have implemented different software solutions. A desktop application, developed in JAVA, permits to create the PIS through a PC placed in their office or at home. During the visit, the guides can interact with their PISs using an application on a multi-touch display, implemented using the MT4J framework, which supports the briefing phase before the tour. A tablet application, implemented in Android 2.2, is used by the guides during the tour through the remains to show multimedia contents, in order to "augment" and enhance their presentation. The applications use specific APIs to communicate with the services providing contents, e.g., Google Maps, FlickR, YouTube, Wikipedia.

Let us suppose that the user, a male guide, is interacting with the desktop application to create a PIS for the archaeological park of Egnathia, in Southern Italy. As first steps, he logs in the platform and selects the services, among those registered in the platform, which can provide the contents (photo, video, etc.) he needs. Since the user wants to associate contents to specific locations in the park, he also chooses the map as visual template. In Fig. 2, the user has opened the *Tools* panel, in the left margin of the interface, where three tools are available: Media Filter, Age Filter and Search.

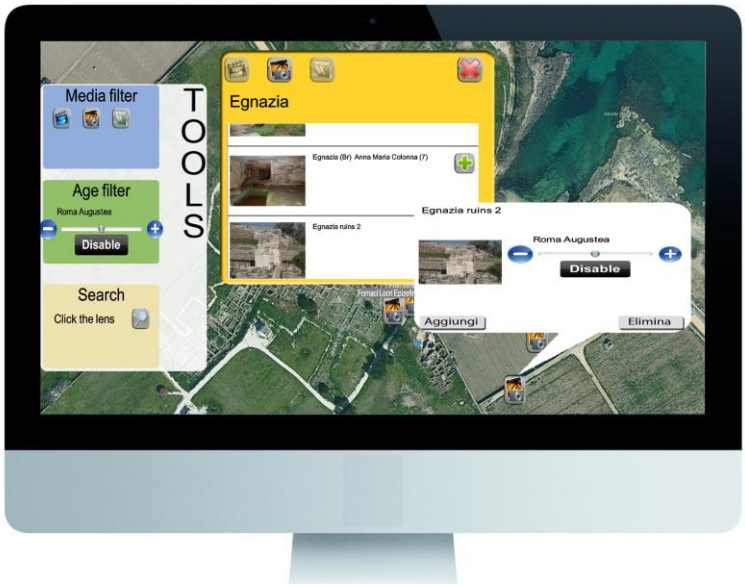

Fig. 2. PIS composition on a desktop computer.

The *Media Filter* is used to display/hide the contents on the map, filtering them according to type (video, photo, wiki). The *Age Filter* is used to display/hide contents according to their historical period. The Media and the Age Filters are examples of filters that the user can add to the PIS by defining some values in a setting panel. When including new content in the PIS, the user annotates the content items with the possible filter values. The PIS execution environment is then able to interpret such settings specified in the composition schema, and renders in the PIS user interface the corresponding widgets for filter-based selection of contents. For example, within the PISs for the archaeological park of Egnathia, the possible values of the Age Filter are: Iron age, Bronze age, Rome Augustea, Rome Trajanea (the main Roman emperors during Egnathia civilization), and Middle Age.

The *Search* tool, displayed at the bottom of the Tools panel, allows the user to retrieve contents from the services. By selecting the lens, a pop-up window is shown in the center of the interface. The example of Fig. 2 refers to a situation in which, after the user has typed the word "Egnazia" in a search text-field, he has filtered out videos and wikis. Thus, the corresponding icons, the first and the third at the top of the pop-up window, are now disabled. The only active is the one referring to photos, which is the type of results he is looking for. For each result preview, title and short description are visualized. By clicking on the "+" button, a new icon appears on the map and the user moves it to the final position; moreover, a call-out associated to the icon allows the user to set the value of the age attribute (Rome Augustea in the example) or to disable it.

The visual composition actions that the user performed through the composition environment are captured and automatically translated into a composition schema, which is interpreted and executed on the device where the composition takes place. In this way, the user immediately sees the effect of any composition action.

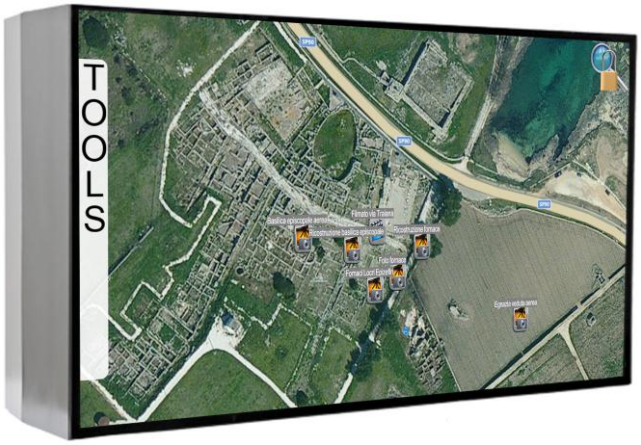

Fig. 3. PIS for the archaeological park of Egnathia visualized on a multi-touch large display.

Fig. 3 shows the PIS on the large multi-touch display. It has been created by the user composing the map of Egnathia with contents referring to videos and photos, each represented with a geo-localized icon and labeled with its title. It looks very similar to the PIS visualized on a desktop computer screen. The more evident difference is the lock pad at the top right corner of the interface, which permits to lock the map at the current position and zoom level, which can be changed by unlocking it. In fact, due to limitations of the infrared touch detection technology of the device we use, when the user moves his hands near to the screen, e.g., to indicate an object without touching it on the screen, these movements could be accidentally interpreted as gestures for changing the map center or the zoom level, generating an annoying flickering of the display.

We have also developed an engine for the execution of the PIS composition schema on a tablet device, to be used during the tour phase (see Fig. 4). Contents are represented by icons, while the titles have been eliminated to avoid overburdening the display (Fig. 4a). Only the contents that refer to places near the user are visualized: thanks to the GPS receiver of the device, it is in fact possible to detect the current position of the user, which is represented on the map by a little yellow man.

a b

Fig. 4. (a) The PIS shown on the tablet; (b) a guide holding the tablet during the tour in the archaeological park of Egnathia.

5 Field study

A field study was conducted in November 2012 at the archaeological park of Egnathia to assess the use of PISs in a real setting. The aim of the study is twofold: 1) to analyze the guides' experience in composing their PIS and in using it when accompanying visitors in the park, and 2) to analyze the overall visitors' experience.

It is worth noticing that the platform for PIS composition is still in the development phase. According to user-centered design, we are greatly interested in collecting feedback in a real context of use. Thus, we performed a field study to validate with the end users the current prototypes, evaluating pros and cons, and getting insights that can improve the current state of the platform and inform about the future development. At this stage of our work, the field study is part of a set of formative evaluations and is mainly focused on qualitative data.

5.1 Participants and Design

The study involved 28 visitors and 2 professional tourist guides, named Achille (male) and Conny (female). Both guides formally agreed in participating in the study by signing an explicit consensus. Each guide accompanied a group of 14 visitors in the visit of the Egnathia park. Visitors were people who had booked a visit to the park. They were heterogeneous as regards age (from 21 to 50 year-old, plus an 8-year old child), gender, and cultural background. They were all Italian but one, a lady from Portugal who currently lives in a nearby city and speaks Italian very well. These visitors were randomly divided in two groups.

5.2 Procedure

The study took place on two days and consisted of two main sessions: 1) PIS composition for organizing the visit, and 2) park visit. The *PIS composition* session occurred on November 7th 2012 in the guides' office. The two guides were given a 1-hour demonstration of the desktop application, accessible through a PC, to be used to compose the PIS. After this, according to the co-discovery exploration technique [17], the two guides were invited to create together a PIS for visiting an archaeological park, named Monte Sannace, in Apulia region. In this way, the guides had the possibility to get familiar with the application. Then, they were asked to create the PIS to be used for the visit of the Egnathia archaeological park. The guides individually created their PIS by positioning on an interactive map of the park all the multimedia contents they would like to illustrate to visitors. At the end of the PIS composition session, the guides were interviewed together to gather impressions, problems and suggestions in order to improve the implemented composition mechanisms and the overall system.

On November 17th, the *park visit* session was performed at the archaeological park of Egnathia. This session was composed of two different phases: 1) the briefing phase at the beginning of the visit, in which the guide accessed his/her PIS through a large multi-touch display (46 inches), placed at the entrance of the indoor park museum, 2) the tour phase, in which the guides accessed their PIS on a tablet (7 inches) during the tour through the remains in the park.

First of all, the visitors were informed that they were participating to a slightly different visit with respect to the traditional one, since some multimedia material available on different technological devices were going to be tested. Thus, some pictures would have been taken but none would have been published in which people faces could be recognized. They all agreed to participate to the visit.

In the briefing phase, the guide interacted with his/her PIS on the multi-touch display to introduce visitors to the history of Egnathia and the remains that they were going to see in the park. After this, the tour phase began. During the tour, guides could use the tablet to show visitors the contents of their PIS regarding the remains. In both phases,

guides could search for new contents and, possibly, update their PIS. The visit session lasted on average 1hour and half.

At the end of the visit, each visitors' group participated in a focus group where their impressions on the overall visit experience were collected. The two guides were interviewed together again at the end of the visit, to discuss in more details their experience, highlighting pros and cons of PIS use.

5.3 Data Collection

It is not easy to assess user experience, nor specific techniques to be used are yet available [18]. Often, all researchers rely on the triangulation of different techniques. This approach was followed in the study reported here. More specifically, in order to analyze the guides' experience in composing their PIS and using it (the first objective of our study), we gathered data through naturalistic observation of the guides while: 1) composing their PIS on the desktop, 2) interacting with the created PIS on the multi-touch display during the briefing phase, 3) interacting with the tablet during the tour phase. These data were complemented by the guides' comments gathered during the interviews after the PIS composition and at the end of the visit of the Egnathia park.

The second objective of our study was to get information on the visitors' experience. Thus, data collection consisted of naturalistic observation of visitors during the visit and a focus group at the end of the visit.

In the PIS composition session, two HCI experts observed the two guides creating the PIS, one took notes on paper and the other videotaped all interactions. At the end of the session, they interviewed the two guides. The interview was audiotaped. Six HCI experts (three experts for each group) followed the park visit session, videotaping and taking notes of the main events. At the end of the visit, the three experts moderated the focus group with the visitors' group they have observed. The focus groups were audiotaped. Moreover, the two guides were interviewed again, with the same modality of the previous interview.

The set of notes collected by the experts in the two sessions was substantially extended by video- and audio-analysis. Two researchers transcribed the videos and the audios and independently double-checked some 65% of the material. If the inter-rater agreement was less than 70%, the researchers discussed the differences and reached an agreement. Final reliability was high (agreement over 90%).

5.4 Results

Results are presented in three different parts, depending on the phase they are referring to: composition phase, briefing phase, and tour phase.

Composition phase

In this phase, the guides were observed while composing their PIS for visiting the archaeological park of Egnathia using the desktop application. In general, the usability problems they experienced were not so serious to stuck them; they were indeed able to continue the PIS composition without the help of the two HCI experts. Both guides appeared disoriented by the few contents returned by some of the searches they had performed; they tried to refine the search by typing different keywords and, finally, added the most appropriate multimedia material available on the Web.

At the end of this phase the two guides were interviewed together. As overall impression, they said they appreciated the ease of use of the application, in particular the possibility to quickly put the retrieved content on the park map. They were rather satisfied by the PIS they had created and they were confident that it would be a valuable support during the visit. Achille jokingly said to Conny: *"When this system will be finally released, I'll call you the day before a visit to ask suggestions about what to include in my PIS"*.

Briefing phase

The briefing aimed at both introducing visitors to the history of Egnathia and providing some preliminary information. The briefing time, during which the guides used the multi-touch display, was different: 28 minutes and 35 seconds for Achille, and 11 minutes and 45 seconds for Conny. During his interaction with the multi-touch display, Achille experienced 3 interaction difficulties due to some technology limits: 1) due to a temporary loss of internet connection; 2) in a situation in which Achille was not able to close the pop-up window touching the "X" icon, which was located near the display border (our multi-touch device is not very sensitive along its borders); 3) in the few situations he had to use the virtual keyboard displayed on the screen, due to low precision of the device in correctly detecting the pressed key. Conny used the multi-touch for about one-third of the Achille's time; she had only one problem with the use of the multi-touch keyboard. However, they were able to autonomously manage such difficulties.

Both guides appeared quite relaxed in using the multi-touch display. They illustrated the multimedia contents they had previously inserted in their PISs. They were able to search new content without difficulties related to the search functionality. Specifically, Achille performed 4 searches, and only 1 out of 4 was not successful, in the sense that the retrieved contents did not satisfied his needs. Conny performed only 1 search.

During the briefing phase, all visitors appeared very interested in the multimedia contents illustrated by the guides on the multi-touch display: they asked questions to their guide, commented images among them, and in general appeared engaged and stimulated by the shown material. This was confirmed in the focus group, in which visitors explicitly expressed their positive opinion about the briefing phase. They also said that they would have liked a debriefing phase at the end of the visit, i.e., a phase in which to deepen some topics and possibly look again at the multimedia resources on the multi-touch display, in order to comment with the guide those aspects that during the visit had captured their curiosity.

It is worth noticing that, when the search for new content required more than 2 minutes, visitors appeared to be disturbed and started chatting among them and looking around. Also, in the focus group, some visitors remarked that the position of the multi-touch display generated some problems since, when the guide was interacting with the display, he partially covered it and visitors moved their head or their body, since they were curious to see all the steps of the interaction.

Tour phase

In the tour phase, the two guides accompanied the visitor group through the remains in the outdoor park. The guides were free to use their tablet as well as the panels located in the park to better present the park remains. Achille and Conny used tablet and panels in different ways. Conny was more prone to the use of such tools; in fact she used the tablet 9 times and the panels 9 times. In total, she spent 7 minutes and 53 seconds to interact with the tablet, and 3 minutes and 58 seconds to show images on the panels. Achille used such tools very little: he used a panel once for 10 seconds and the tablet once for 1 minute.

Both guides performed searches through the PIS on the tablet. In 3 out of 9 times in which Conny interacted with the tablet, she performed a search. Only one search did not get results of her interest. The only time Achille used the tablet was to perform a search. Specifically, it happened that the Portuguese visitor said that she loves the Roman history and she had visited some Roman archaeological parks in Portugal. Achille was very intrigued and started to make searches to understand similarities and differences between the Portuguese sites and Egnathia. From the retrieved images, similarities between the two archaeological sites were evident. In their last interview, the guides told us that, during the many visits they have performed in their career, very often visitors interrupt them to integrate the guide's presentation with their own knowledge, e.g., history teachers report something they studied, archeologists mention something about a recent discovery in another site, etc. They said that, after the visit, they like to study and analyze more in depth the information given by such visitors, and therefore generally search on the Web, or request

material to their colleagues by e-mail or by phone. This modus operandi allows them to enrich their knowledge in preparation to the successive visits. The guides clearly remarked that the PIS would improve the acquisition and storage of new knowledge very much.

Both guides remarked that, during the tour, searches requiring more than 2 minutes interrupted the narrative and distracted visitors. Moreover, they said that, even if they did not feel uncomfortable during this waiting time, they would have preferred to get more material without the delay due to the internet connection, i.e., from local repositories.

Achille and Conny said that they would have liked to use the tablet more, since they appreciated its support in making available useful material. Conny explained that she had used her PIS so little during the tour because she had inserted in it many images that were available on the panels in the park. Thus, she had preferred to show such images on the panels since the tablet was too small for a group of 14 persons.

The small tablet size emerged also in the focus groups with visitors, who said that they preferred to look at images on the panels rather than flocking together around the guide to see them on the tablet. They also complained about the brightness of the tablet screen, compromised by external factors, such as sunlight.

5.5 Discussion

The objective of this study was to assess the value of the PIS, accessible from different devices, in enhancing visits at archaeological parks. To this aim, we have analysed the experience of the two actors involved in a visit: the guide and the visitor. The guide has a double role: 1) composer, i.e. s/he creates her/his PIS; 2) end user, i.e. s/he uses the PIS during the visit to illustrate the park remains to visitors. The visitors participate in an visit which is enhanced by the availability of different types of multimedia materials and, thanks to the possibility given by the PIS to search new content, their curiosity may be better satisfied than in traditional visit.

Composing the PIS with a desktop application did not create any problem to the guides. They appreciated the support of the PIS in organizing the material for the visit. However, the guides complained about the scarce material they were able to find when searching the services available in the platform. This is a problem common to all service-based applications, which have to rely either on contents made available by third-parties or on user-generated contents. To limit this problem, more sensible services should be added into the platform; they can be further third-parties services, if any responding to the user needs exists, but they can also be local and ad-hoc created collections of contents, maintained by domain experts and even fed by the end users themselves by adding self-produced material. Also, given that the services used for the study in the Egnathia park are Web 2.0 resources, the guides could publish online their own material (e.g., videos, pictures, Wikipedia pages) that can thus be easily accessed through the composition tool. This of course requires a more intensive use of the system by the guides, since they have to realize which material is missing and to enrich consequently their public online collections.

Both guides and visitors appreciated very much the briefing phase with the support of the multi-touch display, even if it lasted much longer than in traditional visits, where the briefing to introduce visitors to the archaeological park is about 5 minutes at most. Nobody complained about this longer phase; on the contrary they all said: "*It's worth it!*". The multi-touch display is very valuable in this phase of the visit, since it allows the guides to present much more multimedia materials related to park elements, which enrich a lot their spoken presentation. The visitors' satisfaction is confirmed by their request of a debriefing phase at the end of the visit. As pointed out in several studies, e.g. [6, 19], a debriefing phase would be very useful, since it provides the opportunity to deepen and elaborate the information received during the visit in order to consolidate the acquired knowledge. During the debriefing, points of interest that for time constraints were not possible to visit can be quickly illustrated. For example, in the specific case of Egnathia, the necropolis is far from the main city and, often, it is not visited. In a debriefing phase, the guide could present it by showing pictures or videos.

Summarizing, the study results showed a general appreciation of use of the multi-touch display in the context of the visit. However, a difficulty was generated by the position of the multi-touch display. It was positioned on a support 110 centimeters high. For this reason, some visitors could not see the whole display. In future installations, it would be better to use a higher support (at least 150 centimeters), placing it on a platform of at least 50 centimeters on which the guide will get on. In this way, the display will be better visible by all visitors. However, the fact that the visitors moved to see the display is a symptom of their interest in looking at the material showed by the guide's PIS.

A negative aspect of the use of the PIS on the multi-touch display was the waiting time of a search for new content. This was in part due to the time for typing the search keywords and in part to the low connection speed. However, the search through composition tool is limited to the services made available in the platform (i.e. Flickr, YouTube and Wikipedia). Thus, the search for very specific material can often be unsuccessful, and this might easily bother guides and visitors. As already commented before, the problem can be reduced by adding in the platform further contents, especially ad-hoc collections of contents. Anyhow, it is evident that search for completely unknown content should be avoided; search is not the main task to be performed when using the PIS.

Before the study, we expected a larger use of the PIS on the tablet during the tour phase, since it could show images of monuments and other element of interest helping visitors to reconstruct the old appearance of such elements and figure out how life used to be at ancient times. Actually, Achille did not show any multimedia content and used the tablet only for one search of a new content. The video analysis revealed that, in a specific situation, Achille exclaimed: "*It is a pity that I do not have a picture to show you!*" However, he did not consider the possibility to use the tablet for searching the picture. Since in the interviews he was clearly enthusiastic about the used technological tools, it seems that he would need more time to appropriate of these tools. This also holds for Conny. She used the tablet more times but she had inserted in her PIS primarily pictures that were also reproduced on the panels in the park rather than additional material that could complement what it is already available. It is evident that visitors preferred to look at the images on the panels rather than on the small screen of the tablet, whose visibility is compromised by the sunlight. To overcome this problem, we are going to implement the possibility to visualize some contents of the guide's PIS on the visitors' smartphones. Moreover, we are also developing new solutions to allow the users to share the PIS and allow others to reuse it.

6 Related work

In line with the so-called *culture of participation* [9], our research focuses on participatory approaches, aimed at supporting collaboration and communication by providing users with the means to become co-creators of new ideas, knowledge, and products [20]. In particular, we focus on methodologies and techniques to let end users actively and flexibly compose contents and functionality within interactive, multi-device workspaces that can serve their situational needs.

In this scenario, the Web mashup paradigm provides a viable solution to support the composition aspect. Web mashups are composite applications, where the "components" are heterogeneous, such as Web services, RSS/Atom feeds, user interface widgets, JavaScript libraries, or simply content extracted (wrapped) from common HTML Web pages. Mashups especially promote integration at the user interface level, giving end users the possibility to achieve, with few efforts, full-fledged applications even by non-programmer users [21]. This potential as "composition paradigm for the end-users" makes mashup composition different from the more traditional Web service composition. However, this potential is still rarely exploited. The research on mashup has devoted so far little attention to easing the mashup development process. Often, mashup creation requires manual programming of the service integration.

Some studies show that even those platforms that claim to simplify the mashup development (e.g., Yahoo!Pipes) are still difficult to use by non-technical users [15].

Our work tries to exploit the potential of mashup models and technologies, to create composition paradigms and tools based on intuitive visual mechanisms. A visual composition paradigm strongly characterizes our approach [22], especially with respect to others requiring the adoption of specific design notations (as for example in [23] or also in Yahoo!Pipes) or even scripting languages (as for example in [24]). Also, our approach is easily customizable to the specificity of the usage domain, thus offering a solution to the problem of lack of domain specificity, observed in literature in relation to the mashup composition platforms [15, 16]. In order to be really valuable for the end users, especially to support critical activities, e.g., within work practices, general purpose tools, although valid across different, variable domains, are not as effective as interactive paradigms that accommodate the domain specificity, i.e., end users' skills and needs. Similarly to other composition tools [23], our platform supports the composition of heterogeneous services, offering therefore the possibility to extend the platform with any kind of resources that make sense with respect to a specific domain. The possibility to customize the user interface of the interactive workspaces (both for PIS composition and execution) enables tuning the generic composition paradigm to the specificity of the end users' needs. This last feature seems yet unexplored in the scenario of the composition solutions so far proposed [22].

A number of approaches have been proposed to support the adaptation of web applications to mobile devices for displaying and manipulating HTML pages [25], by using ontology-based annotations [26] or model-based representations [27], [28]. To the best of our knowledge, there is however no other work so far that has attempted to exploit composition platforms, like the one described in this paper, to the cultural heritage domain. On the contrary, since many years mobile technology has been employed to support visits to sites of cultural interest, especially museum. The first systems were implemented on PDAs and they did not have any connection with other devices (e.g., [29]). In more recent proposals, like those in [30, 31], the application on the mobile device becomes a virtual companion to support a more engaging and social experience of museum visits.

Much less attention has been devoted to support visitors of outdoor historical sites or museums. Among the most significant proposal, [32] presents an interactive installation designed to facilitate and support visitor engagement in a living history museum. The *Explore!* system then implements an educational game to stimulate children's interest and facilitate history learning through the analysis of the remains in an archeological park [6]. Because of their potential of motivating and engaging children, but also adults, games have been proposed by various authors for enhancing cultural heritage experiences. Examples are in [33-35].

Finally, large interactive displays have been recently installed in museums and galleries. In most cases they use a horizontal display surface (tabletop displays). For motivations and examples, the reader may refer to [36] and to [37].

7 Conclusion

In this paper we have discussed the use of composition technologies for allowing end users to create Personal Information Spaces, i.e. interactive workspaces, which can support their daily activities. The use of PISs described in this paper aims at bringing practical value to different stakeholders in the context of visits to archaeological parks. However, the approach is relevant in several application domains. For example, we are currently investigating in which way PIS composition can offer support for important social problems, like those in Health 2.0. and the diffusion of well-being practices.

A field study, which is part of a set of formative evaluations, allowed us to analyze guides' experience in composing and using PIS, and the impact on the overall visitors' experience during the visit at an archeological park.

The study has shown that the guides appreciated the usefulness of PISs, in particular the good mapping with their working activities. On their side, visitors enjoyed the possibility of looking at pictures and videos that enhanced the guides' spoken presentation. Wider studies, e.g., comparing a traditional visit with the one enhanced with the proposed technology, will be performed at later development stages. As illustrated in the Discussion section, the results of the study highlighted many important aspects that deserve more attention in future work, such as the opportunity to share some contents among the guide's tablet and the visitors' smartphones. We are also interested in investigating user appropriation of the proposed tools [38], i.e., if a long-term use of PISs could have a positive impact on guides' working activities. We agreed with the two guides that they will have the possibility to use the platform on both PC and tablet for a period of two months, during which they will be asked to write a diary for reporting their activities and impressions; they will also be regularly interviewed and occasionally observed.

References

1. Merriman, T.: Public Archaeology. Routledge, London, UK (2004)
2. Copeland, T.: Presenting archaeology to the public. In: Merriman, T. (ed.), Public Archaeology, pp. 132-144. Routledge, London, UK (2004)
3. Ardito, C., Buono, P., Costabile, M.F., Lanzilotti, R., Pederson, T., Piccinno, A.: Experiencing the Past through the Senses: An M-Learning Game at Archaeological Parks. IEEE Multimedia 15(4), pp. 76-81 (2008). 10.1109/MMUL.2008.87
4. Costabile, M.F., Angeli, A.D., Lanzilotti, R., Ardito, C., Buono, P., Pederson, T.: Explore! possibilities and challenges of mobile learning. In: 26th annual SIGCHI conference on Human factors in computing systems (CHI '08), Florence, Italy. pp. 145-154. ACM, New York, NY, USA, (2008)
5. Ardito, C., Costabile, M.F., Lanzilotti, R.: Gameplay on a Multitouch Screen to Foster Learning about Historical Sites. In: Advanced Visual Interfaces (AVI'10), Rome, Italy. pp. 75-78. ACM, New York, NY, USA, (2010)
6. Ardito, C., Costabile, M.F., De Angeli, A., Lanzilotti, R.: Enriching exploration of archaeological parks with mobile technology. ACM Trans. Comput.-Hum. Interact. 19(4), Article 29, pp. 1-30 (2012)
7. Cappiello, C., Matera, M., Picozzi, M., Sprega, G., Barbagallo, D., Francalanci, C.: DashMash: A Mashup Environment for End User Development. In: Auer, S., Díaz, O., Papadopoulos, G. (eds.), Web Engineering - ICWE 2011. Vol. LNCS 6757, pp. 152-166. Springer, Berlin Heidelberg (2011)
8. Cappiello, C., Matera, M., Picozzi, M., Caio, A., Guevara, M.T.: MobiMash: end user development for mobile mashups. In: 21st International Conference Companion on World Wide Web (WWW '12 Companion), Lyon, France. pp. 473-474. ACM, New York, NY, USA, (2012)
9. Fischer, G.: End User Development and Meta-Design: Foundations for Cultures of Participation. Journal of Organizational and End User Computing 22(1), pp. 52-82 (2010)
10. Cappiello, C., Daniel, F., Matera, M., Picozzi, M., Weiss, M.: Enabling end user development through mashups: requirements, abstractions and innovation toolkits. In: Costabile, M.F., Dittrich, Y., Fischer, G., Piccinno, A. (eds.), End-User Development - IS-EUD 2011. Vol. LNCS 6654, pp. 9-24. Springer, Berlin Heidelberg (2011)
11. Costabile, M.F., Fogli, D., Mussio, P., Piccinno, A.: Visual Interactive Systems for End-User Development: A Model-Based Design Methodology. IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans 37(6), pp. 1029-1046 (2007)
12. Costabile, M.F., Dittrich, Y., Fischer, G., Piccinno, A. (eds.): Proceedings of the 3rd International Symposium on End-User Development (IS-EUD 2011). Springer, Berlin Heidelberg (2011)
13. Lieberman, H., Paternò, F., Wulf, V. (eds.): End User Development. Springer (2006)
14. Beyer, H., Holtzblatt, K.: Contextual design: defining customer-centered systems. Morgan Kaufmann, San Francisco (1998)

15. Namoun, A., Nestler, T., Angeli, A.: Conceptual and Usability Issues in the Composable Web of Software Services. In: Daniel, F., Facca, F. (eds.), Current Trends in Web Engineering - ICWE 2010. Vol. LNCS 6385, pp. 396-407. Springer, Berlin Heidelberg (2010)
16. Casati, F.: How End-User Development Will Save Composition Technologies from Their Continuing Failures. In: Costabile, M., Dittrich, Y., Fischer, G., Piccinno, A. (eds.), End-User Development - IS-EUD 2011. Vol. LNCS 6654, pp. 4-6. Springer, Berlin Heidelberg (2011)
17. Kemp, J.A.M., Gelderen, v.T.: Co-discovery exploration: an informal method for iterative design of consumer products. In: Jordan, P.W., Thomas, B., Weerdmeester, B.A., McClelland, I.L. (eds.), Usability Evaluation in Industry, pp. 139-146. Taylor and Francis, London (1996)
18. Roto, V., Ketola, P., Huotari, S.: User Experience Evaluation in Nokia. In Proc. of UXEM: User Experience Evaluation Methods in Product Development Workshop at CHI '08 (2008). Available at: http://www.cs.tut.fi/ihte/CHI08_workshop/papers.shtml. Last access: January 19th, 2013
19. Ardito, C., Lanzilotti, R., Costabile, M.F., Desolda, G.: Integrating traditional learning and games on large displays: an experimental study. Educational Technology & Society 16(1), pp. 44-56 (2013)
20. Latzina, M., Beringer, J.: Transformative user experience: beyond packaged design. Interactions 19(2), pp. 30-33 (2012)
21. Daniel, F., Yu, J., Benatallah, B., Casati, F., Matera, M., Saint-Paul, R.: Understanding UI Integration: A Survey of Problems, Technologies, and Opportunities. IEEE Internet Computing 11(3), pp. 59-66 (2007)
22. Aghaee, S., Nowak, M., Pautasso, C.: Reusable decision space for mashup tool design. In: 4th ACM SIGCHI symposium on Engineering interactive computing systems (EICS '12), Copenhagen, Denmark. pp. 211-220. ACM, New York, NY, USA, (2012)
23. Daniel, F., Casati, F., Benatallah, B., Shan, M.-C.: Hosted Universal Composition: Models, Languages and Infrastructure in mashArt. In: 28th International Conference on Conceptual Modeling (ER '09), Gramado, Brazil. pp. 428-443. Springer-Verlag, Berlin, Heidelberg, (2009)
24. Maximilien, E.M., Wilkinson, H., Desai, N., Tai, S.: A Domain-Specific Language for Web APIs and Services Mashups. In: 5th international conference on Service-Oriented Computing (ICSOC '07), Vienna, Austria. pp. 13-26. Springer-Verlag, Berlin, Heidelberg, (2007)
25. Buyukkokten, O., Kaljuvee, O., Garcia-Molina, H., Paepcke, A., Winograd, T.: Efficient web browsing on handheld devices using page and form summarization. ACM Transactions on Information Systems 20(1), pp. 82-115 (2002)
26. Yesilada, Y., Stevens, R., Harper, S., Goble, C.: Evaluating DANTE: Semantic transcoding for visually disabled users. ACM Trans. Comput.-Hum. Interact. 14(3), pp. 14 (2007)
27. Fonseca, J.M.C.: W3C Model-Based UI XG Final Report (2010). Available at: http://www.w3.org/2005/Incubator/model-based-ui/XGR-mbui-20100504/ Last access: January 8th, 2013
28. Paternò, F., Santoro, C., Spano, L.D.: MARIA: A universal, declarative, multiple abstraction-level language for service-oriented applications in ubiquitous environments. ACM Trans. Comput.-Hum. Interact. 16(4), pp. 1-30 (2009)
29. Not, E., Peterelli, D., Stock, O., Strapparava, C., Zancanaro, M.: Person-Oriented Guided Visits in a Physical Museum. In: International Conference on Hypermedia and Interactivity in Museums (ICHIM '97). Archives & Museum Informatics, Le Louvre, Paris, France, (1997)
30. Stock, O., Zancanaro, M.: PEACH - Intelligent Interfaces for Museum Visits (Cognitive Technologies). Springer-Verlag New York, Inc. (2007)
31. Barbieri, G., Celentano, A., Orsini, R., Pittarello, F.: Understanding Art Exhibitions: From Audioguides To Multimedia Companions. In: Int. Conf. on Distributed Multimedia Systems (DMS 2009). pp. 250-255. Knowledge Systems Institute, Skokie, IL, USA, (2009)
32. Ciolfi, L., McLoughlin, M.: Designing for meaningful visitor engagement at a living history museum. In: 7th Nordic Conference on Human-Computer Interaction: Making Sense Through Design (NordiCHI '12), Copenhagen, Denmark. pp. 69-78. ACM, New York, NY, USA, (2012)

33. Ballagas, R., Kuntze, A., Walz, S.: Gaming Tourism: Lessons from Evaluating REXplorer, a Pervasive Game for Tourists. In: Indulska, J., Patterson, D., Rodden, T., Ott, M. (eds.), Pervasive Computing. Vol. 5013, pp. 244-261. Springer Berlin / Heidelberg (2008)
34. Sintoris, C., Stoica, A., Papadimitriou, I., Yiannoutsou, N., Vassilis, K., Avouris, N.: MuseumScrabble: Design of a mobile game for children's interaction with a digitally augmented cultural space. INT J. of Mobile Hum.-Comput. Interact. 2(2) (2010)
35. Huizenga, J., Admiraal, W., Akkerman, S., ten Dam, G.: Mobile game-based learning in secondary education: engagement, motivation and learning in a mobile city game. Journal of Computer Assisted Learning 25(4), pp. 332-344 (2009)
36. Geller, T.: Interactive Tabletop Exhibits in Museums and Galleries. Computer Graphics and Applications, IEEE 26(5), pp. 6-11 (2006)
37. Hinrichs, U., Carpendale, S.: Gestures in the wild: studying multi-touch gesture sequences on interactive tabletop exhibits. In: 29th annual conference on Human factors in computing systems (CHI'11), Vancouver, BC, Canada. pp. 3023-3032. ACM, New York, NY, USA, (2011)
38. Dix, A.: Designing for appropriation. In: 21st British HCI Group Annual Conference on People and Computers: HCI...but not as we know it - Volume 2 (BCS-HCI '07), University of Lancaster, United Kingdom. pp. 27-30. British Computer Society, Swinton, UK, (2007)