Reusing Multimedia Content for the Creation of Interactive Experiences in Cultural Institutions

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Abstract. Information and Communication Technologies (ICT) have changed the society, including the recreational experiences. ICTs have created new spaces for the recreational participation, which often only recreate the same experiences on virtual spaces. These technological advances are one of the main drivers of the cultural and creative production. As people use ICTs in different activities of their daily life, such as home entertainment, they demand a higher sophistication level in cultural heritage applications. This paper describes the implementation of a software framework to generate cultural experiences, aiming at their integration in current flows of creative processes; semantic standardized access to different distributed knowledge sources; flexible integration of services; and content oriented visualization. It is worth highlighting that this platform will allow users without a technology background (content producers, education departments of cultural institutions) to generate new experiences based on reusing existing multimedia contents and designing the stories they want to tell.

Keywords: Authoring Tool, storytelling, multimedia content, Europeana.

1 Introduction

There are many initiatives to make cultural content available online on the basis of standard easily searchable metadata descriptions. An outstanding example is Europeana that aggregates large amounts of annotated multimedia cultural data. Each heritage piece in this online collection tells a story about why it is significant, what it shows, where it came from and how it relates to other items in the collection and elsewhere. Although huge amounts of resources have been invested in digitization and indexation of the contents, there is still a lack of real-world applications based on reusing multimedia contents coming from large-scale repositories. Thus, there is an urgent need to turn this content into a valuable and coherent experience for users.

On the other hand, the development of multimedia contents has influenced storytelling, an ancient art form where experiences, events and actions are conveyed in words, images and sounds. Traditionally, this art form has been an oral performance with an interactive relation between the storyteller and the audience. A single person (the storyteller) communicates a series of events to a passive audience.

The advent of digital contents has given rise to the so-called digital storytelling, a combination of the art of telling stories with a mixture of digital graphics, text, recorded audio narration, video and music to present information on a specific topic.

Although people have written and told stories for thousands of years, digital storytelling partially driven by audience participation has emerged in the last 30 years. Even nowadays, the skills needed to author successful interactive stories are still not well understood, as the experience creators are used to traditional static narratives in print, film and television formats. Interactivity encloses planning many types of interactions with the objects in the experience, making it much more complex to maintain coherence and control over the dynamic story. To author a successful story, the experience creators should have the skills of a creative master and the technical knowledge of the data structures and software tools used for a story engine.

Furthermore, most of the multimedia applications today do not adequately support adaptation to different visualization channels, namely mobile applications, Web-based browsers or gesture-based devices. Many existing authoring tools have been implemented in specific technologies for target situations (for example, mobile devices in a gallery). Thus, content creators and developers must face the challenge of targeting different channels in a cost-effective way.

This paper describes the implementation of the GeneraTour framework to author multichannel cultural experiences, aiming at their integration in current flows of creative processes; semantic standardized access to different distributed knowledge sources; flexible integration of services; and content oriented visualization. It is worth highlighting that this platform will allow users without a technology background (content producers, education departments of cultural institutions, experience creators) to generate new experiences based on existing Europeana multimedia contents and designing the stories they want to tell.

This paper has been structured as following. Sections 2 and 3 describe in detail the two main pillars of the developed framework, namely authoring tools and storytelling in Cultural Heritage. The following section describes the GeneraTour framework. The final section includes some conclusions and future work.

2   Authoring Tools

2.1   Definitions

Bulterman and Hardman (1995) [6] defined an authoring system as "a program that assists the user in managing the creative task of specifying the placement and relative order of media object events". They have categorized authoring tools into four basic approaches:

- Graph-based authoring. This approach uses a schematic diagram of the control flow interactions among multimedia objects.
- Timeline-based authoring. These systems provide a schematic diagram of the dataflow interactions among multimedia objects. A number of events are shown in parallel relative to a common axis.

- Programming-based authoring. Both previous paradigms use graphs and illustrations to describe the interaction among media items in a presentation. In this case, a programming-based system provides low-level facilities to specify the components, their timing, layout and interactions within a presentation.
- Structure-based authoring. This approach separates the definition of the logical structure of a presentation and the media objects associated with a document.

As many of the existing authoring tools, GeneraTour aims at providing a framework for the management and authoring of cultural multimedia assets for non-technical users with limited expertise in the field of computer programming. During the years, several authoring approaches have been implemented with clear differences in their coverage of the workflow process as well as in their user interface concept. This section has categorized such approaches on the basis of the user interaction channel of the experience authored.

2.2   Authoring Tools for Web-Based Exhibitions

Web-based exhibitions have become a common means for cultural institutions to provide access to Cultural Heritage information resources to the public. Authoring and managing a Web-based exhibition can be a tedious and time-consuming task involving a set of skills that may not be available in a cultural institution context. Thus, in order to simplify the creation of such exhibitions, several authoring tools have been developed. All these systems facilitate the development of multiple versions of the same exhibition in different contexts by separating content and presentation.

One example is the ViEx system [5] based on three major components: a content management system; its underlying content database; and a set of layout templates. The content of a ViEx exhibition is organized in a layout-independent way, as building blocks for the experience may be pages, pictures with descriptive information, video, audio, text and panoramas. One of its main disadvantages is the lack of support for metadata.

Costagliola *et al* (2002) [8] presented a formal approach called CREW, specialized in the development of 3D virtual exhibitions of Cultural Heritage. The tool is mainly oriented to the content experts, such as the curator of the exhibition, the art expert, the media expert and the layout designer. The approach provides a set of visual modelling languages tailored to the specification of virtual exhibitions. Such languages have been integrated in an authoring tool which supports the key figures to carry out the tasks on the basis of visual interfaces.

Furthermore, Patel *et al* (2005) [20] developed the ARCO system to create, manipulate, manage and present artefacts in virtual exhibitions, both internally within the museum environment and over the Web. Conceptually, the system includes the three major functions of content production, management and visualization. This system emphasizes creating 3D digital copies of artefacts on the Web, limiting its users to cultural organizations with 3D contents.

Yang, Ramaiah and Foo (2007) [30] developed the VAES framework to create, update, extract and search metadata of artefacts and exhibitions stored in a database. A virtual exhibition is created on the basis of a predefined exhibition and artefact metadata stored in the database. An authoring tool provides a direct manipulation work area for users to browse, display and layout the exhibition page content that is extracted from the database.

More recently, Chittaro *et al* (2010) [7] implemented a high-level tool to build 3D virtual exhibitions from pre-existing 3D models in order to design virtual visits. The tool provides a 3D interface in first-person view to navigate through the virtual space and arrange exhibits. Artificial Intelligence (AI) techniques allow defining interesting points of view inside the exhibition area. These points can be connected to create a virtual tour. The tool has been used to build the virtual visit of a church with representative Renaissance frescoes.

Finally, the eXhibition:editor3D creates virtual 3D exhibitions from existing digitalized exhibition content like 3D assets, photographs, videos and audioclips [18]. It allows the curators and editors to design and preview upcoming exhibitions; archive temporary exhibitions; create interactive 3D presentations for multimedia terminals; or create catalogues and websites. The editor can organize its content in virtual rooms, so that multiple rooms are combined together within a project to present different exhibition rooms.

2.3   Authoring Tools for Mobile Applications

Mobile devices have gained increasing acceptance as platforms for accessing cultural experiences due to their suitability in this field. Thus, the development of authoring tools for the implementation of mobile applications for cultural institutions has attracted a lot of commercial attention. Generally speaking, current tools for authoring mobile applications are light versions of state-of-the-art commercial multimedia authoring tools. This section reviews two of the most representative ones.

On the one hand, Macromedia Flash Lite is one of the most commonly used multimedia authoring tools that has been used in the implementation of a promotional campaign of the natural history museum of the Petrified forest in Lesvos, Greece [10]. On the other hand, NaviPocket has been designed to develop multimedia guides, especially for PDA. Based on NaviPocket, the "Fables" prototype for the Stratis Eleftheriadis Teriade Museum in Greece uses PDA to provide enriched multimedia interpretative information for the collection of "Fables" by Jean de La Fontaine [16]. Although both tools have accelerated the delivery of advanced applications, they are not Open Source, do not support content maintenance and require Windows compatible devices for the development and run-time.

Further research authoring frameworks have been implemented for the implementation of mobile experiences. For instance, Barrenho *et al* (2006) [4] describe the InStory project, which has implemented a platform for the development of exploratory geo-referenced activities. Authoring in this project includes creating and geo-referencing the components, associating media content to them and establishing connections between them. Users can retrieve multimedia content on

their mobile devices while visiting a cultural, historical or natural Cultural Heritage. Finally, Linaza *et al* (2008) [13] implemented an authoring tool for non-expert users to allow the creator of the guide to decide which contents to include and the languages in which the guide will be provided. This tool has been validated in several archaeological sites in order to build interactive multilingual mobile guides based on the J2ME standard.

2.4   Other Types of Authoring Tools

Natural interaction metaphors in cultural institutions include the impression of handling a real book, or flipping pages using touch-screens or gestures. For instance, the DocExplore research project [27] has implemented a technology-based system for the exploration of historical documents. It includes three main applications: the Manuscript Management Tool to manage and annotate collections of digitized manuscripts; the Authoring Tool to build multimedia presentations of augmented documents; and the Viewer to visualize and interact with multimedia presentations. In this case, the aim of the Authoring Tool is related to the definition of a course through the selection of pages from the existing contents.

As it has been presented in this section, the increasing number of technologies and devices can empower further authoring approaches in the field of Cultural Heritage such as innovative multichannel approaches. For instance, NIPPON-multimedia is a multimedia application developed on the basis of the Instant Multimedia technology to coordinate the production of different experiences optimized for different channels (Web, podcast, iOS applications, SmartPhones) [25]. As in the GeneraTour approach, the simple authoring environment enables the edition of the experience and the definition and selection of multimedia content for each element. The framework produces and publishes the final applications for different delivery channels. The main difference with the GeneraTour approach is the additional interaction means of GeneraTour, such as Kinect-based experiences or the traditional catalogues for cultural exhibitions.

3   Storytelling in Cultural Heritage

As it has been previously defined, storytelling is an ancient way of communication and information flow between people. Traditionally, it is an oral performance with an interactive relation between storyteller and audience. The storyteller often uses a set of fragments of plots that are mixed and composed in a fuzzy way [15]. The most common conception of the story is a linear sequence of scenes, which is very popular in cultural institutions, as this type of storytelling allows presenting stories of artefacts and also people who lived the history. As digital media is the major media nowadays, there are several new types of storytelling. This section provides an overview of different approaches in the storytelling field.

3.1   Digital Storytelling

Digital storytelling combines the art of telling stories with a mix of digital graphics, text, recorded audio narration, video and music to present information on a specific topic [24]. A digital story includes all the elements of traditional stories (setting, plot, conflict, theme, character and point of view), as well as other additional elements such as emotional content to engage the audience, voice and images to illustrate the scripts, or pacing to add emotion to the content. Such stories usually adopt a first person narrative point of view.

The use of digital storytelling has become very popular in virtual heritage applications, as stories about events and characters have been added to many projects related to virtual reconstructions. The form of digital storytelling goes from simple text or audio narration to virtual or real storytellers. For instance, Huseinovic and Turcinhodzic (2013) [12] presented a story-guided cultural heritage environment, where the visitor is guided through the virtual museum to present intangible cultural heritage such as legends, tales, poems, rituals or dances. The virtual reconstruction has been first implemented as a computer animation rendered in a movie.

3.2   Collaborative Storytelling

A story can be created individually or by a group. The members of a group (distributed or in the same place) may collaborate on the creation of a story, which can be done synchronously or asynchronously using different media [23]. This collaborative storytelling enables building social interactions and facilitating communication among the members of a community. Collaborative storytelling often takes place in a co-narration form [20], in which participants communicate and exchange ideas orally to generate ideas to build stories.

One of the first approaches in collaborative storytelling has been the linear platform that provides a collaborative space in which participants remix stories using a linear approach. Such stories have exactly one beginning, one middle and one end. Examples include Dramatica [23], CBC4Kids [3] and Lizzy [9]. In such linear platforms, no other story branches are possible.

Digital storytelling can address groups in ways that would not be possible without technology. For example, it can provide individuals in a group with different points of view of a story at the same time, adapting to the behaviour of the group as a whole, rather than just individual behaviour. As an example, TellStory is a Web application that supports the collaborative building of stories [22]. One of the most important issues of TellStory consists in the possibility of the user to use a template in order to address the elaboration of the story through the typical characteristics of a narrative structure.

Finally, StoryMapper is a group-based approach in which the collaboration process is guided by user roles such as teller, organizer or listener [1]. The graphical interface is based on conceptual maps, so that media can be attached to them.

3.3   Interactive Storytelling

One of its main disadvantages is that traditional storytelling does not allow people to interact or alter the plot as users may like. Due to the emergence of information technologies, the cultural and creative industry has begun to explore computational approaches for creating interactive story experiences. Glasner (2004) [11] defined interactive storytelling as a two-way experience, where "the audience member actually affects the story itself". Furthermore, Miller (2008) [17] defined digital storytelling as narrative entertainment that reaches the audience via digital technology and media. Developing interactive narrative experiences is a research subject within different fields, including digital media, artificial intelligence and Human Computer Interaction.

The framework of interactive storytelling is different from the conventional linear story, as the former is a form of non-linear storytelling. While the story begins at one end and goes through a pre-defined sequence to finish at the other end in a linear story, non-linear stories consist of a graph of multiple story "nodes" where each "node" is connected to one or more other "nodes". The connections between these "nodes" represent possible directions the story might take and the branching from one "node" to the next can either be random or based on some sort of interaction rules.

The existing approaches varied across different works. The first published interactive storytelling software that was widely recognized was Façade [14]. The project combines voice acting and a 3D environment as well as natural language processing and other advanced artificial intelligence techniques for robust interactive storytelling.

A further approach named The Virtual Tour Guide provides information to the visitor on the basis of interactive storytelling techniques [26]. Rather than following a predefined tour that is the same for all visitors, the visitor is allowed to make choices to develop the tour and story. The information is segmented in small and easily-understood information pieces that can be combined according to the choices and preferences of the visitor that are stored in the profile and constantly updated by the visitor tracking. The result is a personalized tour.

Moreover, Tuck and Kuksa (2009) [28] describe the Virtual Heritage Tours project about the Cultural Heritage of Nottingham. Users can choose the road they will take, move around and sometimes interact with the action. The narratives are triggered as users approach an object. Finally, Adabala *et al* (2010) [2] have implemented a platform to create interactive narratives on the basis of tangible and intangible heritage elements. The framework enables the creator to compose an interactive narrative that conveys the richness of the information while preserving the relationships among different artefacts that take part in the story.

GeneraTour combines different multimedia contents from distributed heterogeneous databases into a single compelling narrative that could be explored in multiple visualization channels.

4   The GeneraTour Platform

4.1   Main Objectives

GeneraTour is an authoring framework to generate multimedia experiences for cultural organizations, which allows both the management and curation of experiences, and the visualization and experimentation by the final user. Experience creators are provided with a narrative space in which they can add, edit and delete narrative contents. Moreover, as experiences are stored and accessed online, they can be edited and updated in real-time.

One of the main advantages of the framework is the split of the authoring in the strict sense (text, images and audio creation and management) from the generation of specific visualization applications, generally developed for specific devices. Generating such one-channel applications means shaping the interface and the interaction mechanisms, selecting the content, adapting and organizing them into an experience structure.

This limitation has been overcome by the GeneraTour framework, which allows building multichannel experiences with the same authoring tool. A middleware to interpret and execute standard formats on all types of visualization platforms defined for GeneraTour has been implemented. In such a way, the authoring framework generates a single representation of an experience that is shared among different visualization environments (author-once approach).

Finally, it is worth highlighting that this platform will allow users without a technology background (content producers, education departments of cultural institutions) to generate new experiences based on reusing existing multimedia contents and designing the stories they want to tell.

4.2   Technical Description

The front end of the Authoring Tool is a HTML5 and JavaScript Web application based on a Rich Internet Application (RIA) architecture following a Model-View Controller (MVC) design pattern. On the other hand, the back-end runs on a Java server with Apache Web Server and Apache Tomcat. The Authoring Tool includes four main building blocks that represent each of the steps in the authoring process, as shown in Fig. 1.
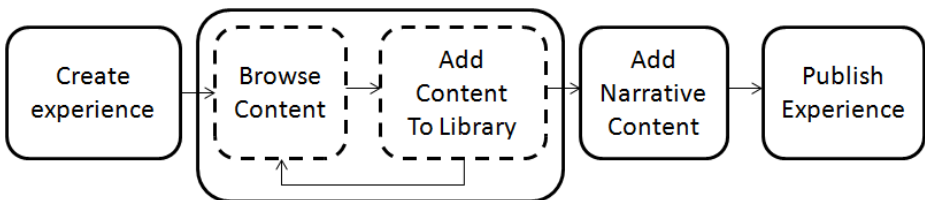

Fig. 1. Work flow of the authoring process

Step 1 is related to the creation or uploading of an experience (Fig. 2). When creating a new experience, the content creator must select the title of the experience as well as the visualization and interaction channel. Five types of channels have been defined for the prototype, such as KinectExperience (gesture-based interaction with Kinect devices over large screens); MobileExperience (Web applications for mobile devices); MuseumExperience (catalogues and other traditional media in exhibitions); WebExperience (Web applications for desktop computers or kiosks) and TourismExperience (Web applications for mobile devices that include geo-located information and Layar-based Augmented Reality features). The creator can also select and load existing experiences (for example, the Euromed experience).
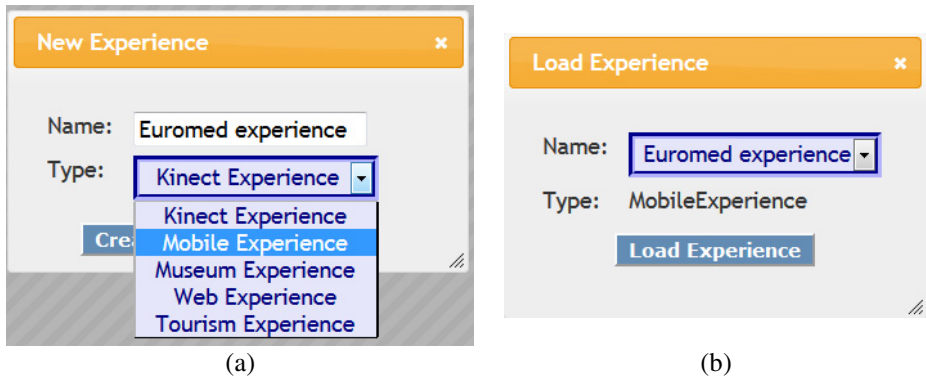

(a)   (b)

Fig. 2. Graphical interface for: (a) creating a new experience, including the definition of the visualization channel; (b) uploading an existing experience

In step 2, creators can navigate and browse through heterogeneous multimedia resources coming from their own institution or external knowledge databases. In order to demonstrate the scalability of the prototype, the platform currently includes two main external data sources: Europeana, accessible through its own API in read-only mode, and Euskomedia, a local database for Basque contents from where contents are imported and duplicated in the GeneraTour database. The performance is direct, as it is enough to introduce the keywords and select the content. Fig. 3 displays the results of a query based on the keyword Picasso. As the query is very generic, more than 298 pages with multimedia contents (image, video, audio) have been retrieved.

The platform is also able to retrieve contents on the basis of advanced filters related mainly to the type of media (text, image, audio, video, book, article,...). It should be mentioned at this point that the type of visualization approach determines the relative weight of media and the amount of information that can be delivered together. Using a large screen, a proper combination of images (video), audio, text and links can be used. On a small device, instead, text must be used sparingly, audio becomes very important, images can be used, but not many at once. Thus, this advance search feature is very helpful for experience creators.
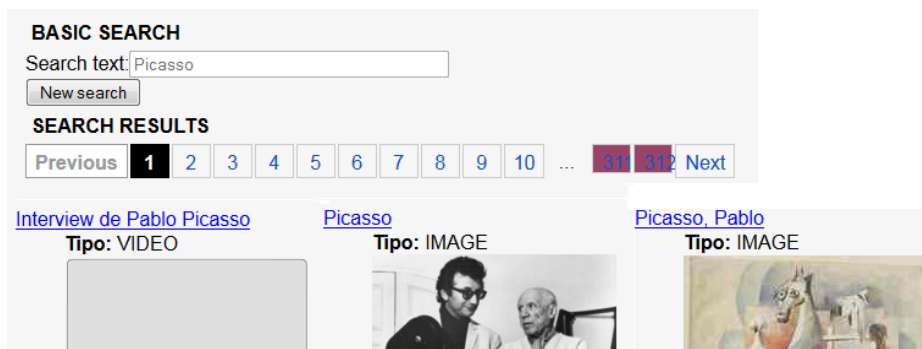
Fig. 3. Graphical interface for browsing and selecting contents from Europeana and other Open Data cultural repositories

When clicking on the content, the creator accesses the corresponding metadata. GeneraTour stores the metadata associated to the multimedia contents selected by the experience creator in the so-called "experience library" (Fig. 4). Such contents are stored as instances of E73.Information_Object class of the CIDOC-CRM ontology. Properties of the instances are automatically initialized with the information available from the data source (Europeana or Euskomedia). In all cases, the experience creator is responsible of analyzing the copyright of the contents in order to check their property rights.
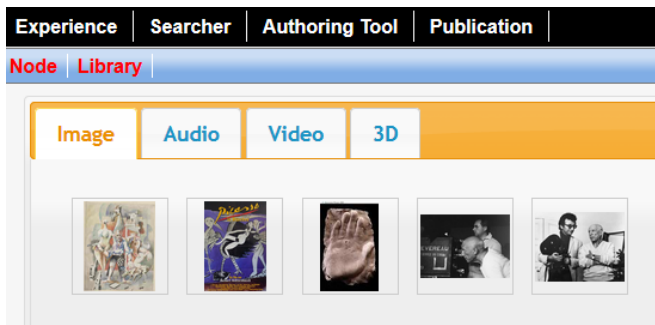

Fig. 4. Selected multimedia contents stored in the "experience library"

In step 3, experience creators are provided with a drag&drop based interface to add, edit and delete narrative content. The platform allows defining several nodes to create an experience. Each node representing a scene of the experience, includes different multimedia contents, such as the title, the text that will be displayed, pictures, video and 3D graphics (Fig. 5). In the case of tourism guides, the creator will add location data for georeferencing.

(a)   (b)

Fig. 5. Creating the storytelling of the experience using the Authoring Tool. (a) Description of each node including the multimedia contents; (b) Node with location data.

Once all the nodes are defined, the relationships among them can be defined to achieve the final end-user experience (Fig. 6). GeneraTour experiences are based on different narrative flows, so that the creator can select the more adequate one on the basis of the content and the visualization and interaction channel. Five different narrative flows have been defined: no sequencing, so that users can view any of the nodes of the experience; linear when exhibits are presented one after the other and the user is forced to follow a path; multiple linear, similar to the previous one but with multiple nodes upstream and downstream; combined when some nodes follow a no sequencing flow and others a linear flow; and conditional, when the user can only access several contents on the basis of predefined rules about the previously experienced nodes.

Once the experience is completely defined, the creator can publish it. The output of the authoring tool is a compressed .zip file (step 4) including several files in JSON format that describe the information for each node; the relationships among the nodes; and the type of experience (mobile, Web-based, Kinect-based). Furthermore, multimedia contents (text, video, pictures and 3D objects) associated to each of the nodes are also included in the file. Remote multimedia contents files are retrieved in real-time before the publication of the experience.

If the experience is to be consumed as a Web application (MobileExperience, WebExperience, TourismExperience), the output .zip file will be the input of a Web REST service that will generate a HTML5 Website. This Website will be automatically published on a Web server, sending back the URL of that Website (Fig. 7).
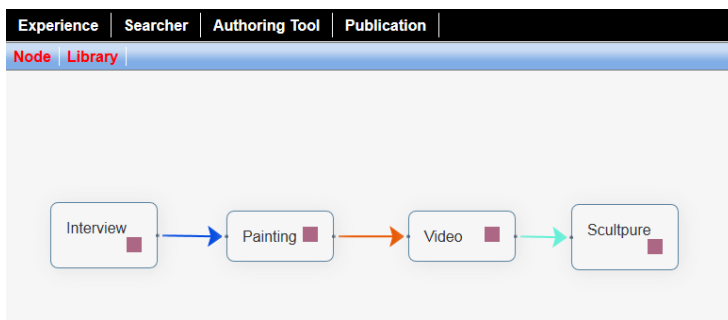
Fig. 6. Linking the nodes of the experience.

Fig. 7. Visualization of the experience in an Android mobile device

Were the experience gesture-based (KinectExperience), the .zip file will also contain the input of a Web REST service that will generate a HTML5 Website compatible with the Microsoft Kinect device. This Kinect-based experience includes three main movements of the hand of the user as a first approach to evaluate the acceptance of the visitors to cultural institutions. Starting with an open hand, users will be able to wave their hand from left to right to go to the next page and from right to left to go back to the last page. The main advantage of the proposed solutions is that the experiences only require a Web browser to run, so that the Kinect device can be installed in any standard desktop computer.

5   Conclusions and Future Work

There are many types of textual, geometric or geographical information, images, videos, audios or 3D information related to Cultural Heritage in a wide range of formats. Europeana is the outstanding example of a large project that stores a significant part of digital information related to Cultural Heritage. However, there are not many experiences of content re-use from Europeana. The bigger current challenge is how to turn all this content into valuable and coherent user experiences.

On the other hand, storytelling in cultural institutions is currently mostly linear and only partially interactive. However, digital technologies such as digital storytelling allow more sophisticated non-linear stories so that visitors can interact with the story at different points in time. Such technologies have a great potential for increasing entertainment for visitors to cultural institutions as they can communicate the heritage in an interactive way.

An Authoring Tool to create interactive multichannel experiences for cultural institutions on the basis of existing multimedia contents has been described in this paper. GeneraTour supports experience creators when developing narrative structures to describe objects and stories of an exhibition. The narrative elements or nodes are re-orderable and editable, so that new nodes can be easily added. Furthermore, the authoring tool can create multichannel experiences from an exhibition, for catalogues and handouts, for online viewing or within a museum space, for mobile applications or for advanced interaction techniques such as Kinect.

The current version of the framework can be considered to be ready for a more formal evaluation. Thus, a formal evaluation of the GeneraTour project is planned in the forthcoming months in order to provide feedback on the usability of the system and on the identification of the main problems encountered.

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