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PERSONALIZED ACCESS TECHNIQUES FOR  
CULTURAL DATA

ΤΕΧΝΙΚΕΣ ΠΡΟΣΩΠΟΠΟΙΗΜΕΝΗΣ  
ΠΡΟΣΒΑΣΗΣ ΣΕ ΠΟΛΙΤΙΣΤΙΚΑ ΔΕΔΟΜΕΝΑ

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# I. Introduction

The digitalization of museums is a task that has combined efforts, budgets and research from many museums, cultural associations and governments around the world. Furthermore, Information and Communication Technologies (ICTs) are utilized in an increasing number of museums world-wide. Many physical museums now have an online presence, with varying degrees of online information. Online Museums can be categorized to different types, depending on the content they provide as well the goal they achieve. There are museums that their Web site contains basic information such as contact details and a listing of exhibitions, informing potential visitors about the museum (brochure museums). As well there are museums that offer extensive online information, interactive online features, multimedia, and searchable or browsable exhibits (content museums, learning museums, virtual museums) [1].

Nowadays Museums encounter several problems, related to lack of space, of organized and detailed information about the exhibits and about the excavation site where they were discovered. The lack of a system which will enhance the educational aspect of the Museum and provide the capability to any visitor to enjoy the services of a personalized museum guide with extra functionality for searching information and designing “routes”, are some other problems that restrict the knowledge that museums can provide through the use of recent technologies. Trying to overcome the previously cited difficulties, the goal of Virtual Museum is two-fold: on one hand, to cope with these problems, on the other, to become more audience-centered and provide access to usable authoritative information as the audience wishes, depending on its interests.

More and more well-known museums around the world have started to spend funds in order to build systems to help visitors navigate virtually through the museum’s exhibits. The exploration of cultural heritage, through the design and development of a Virtual Museum is a task that combines the joint efforts of information technology and communications scientists and archaeologists.

This report aims at presenting personalized access techniques for cultural data. In more detail, a new type of Virtual Museum based on three components: Projection Room, Mobile Tour, and Virtual Wing, is described. The Virtual Museum platform, called iMuse, can be integrated in almost any type of museum; this particular version has been tailored around the offerings of the 13th Ephorate of Prehistoric and Classical Antiquities, in Volos Museum, Magnesia, Greece.

The first three sections of this report describe the services of the iMuse project: Section 2 presents the Projection Room service, Section 3 describes the features of the Mobile Guide/Tour application and Section 4 presents the Virtual Wing application. In Section 5 and 6, available technologies and cultural information systems for the delivery of cultural content are discussed and Section 6 concludes the report.

## II. iMuse Projection Room

The iMuse Projection Room [2] is a web platform for delivering multimedia presentation to groups of visitors. The main objective is to increase access to museums' digital content, using rich multimedia content (text, images, video and sound). The presentations can be accessible either inside the museum, in a special projection room (on-site) or even outside of it via web (on-line) e.g. in schools during a preparation class prior to a museum visit. The platform generates dynamical presentations on cultural heritage considering the personal profile of the audience. The profile of Museums' visitors is composed of their language and their interests. Currently the system supports three languages (Greek, English and France) and three types of roles for different user groups (Museum's archaeologists, tour guides – instructors and visitors) providing different privileges and functionality:

- The Museum staff, through the “Presentation Authoring” functionality, is able to create and store presentations from scratch utilizing the appropriate information stored in the Museum database. This type of group has full access to the system.
- The instructors or tour guides, through the “Presentation Synthesis” functionality, can compose personalized presentations by selecting and combining slides from presentations already created by the Museum's archaeologists. They have fewer privileges than the museum's archaeologists, as they do not have direct access to the exhibit's detailed information stored in the Museum's database. They can only access information stored in slides already edited by the archaeologists.
- A simple visitor, through the “Presentation Projection” functionality, can view a presentation that is already created by the other two groups of users.

Of course, both Museum staff and instructors/tour guides can view the presentations already stored in the system.

The system is designed to support more languages depending on the needs of the Museum. The Projection Room Application exploits modern technology to enhance the educational aspect of the Museum. The idea is to gain the interest of the visitors by attending presentations based on their profile and change the way they collect experience and knowledge.

### A. Presentation Authoring

Presentation Authoring is a complex process, including a number of steps (Figure 1) in order an archaeologist to generate, update and store presentations using information from Museum's exhibit database. Each presentation is composed of a number of slides and each slide includes information about one exhibit. Exhibits can be either artifacts or collections of them in showcases. Two tools provide the archaeologists, the Presentation Authoring functionality: Presentation Creator and

Presentation Editor. Through Presentation Creator archaeologists can:

1. Define the audience profile by setting its language and type.
2. Create a new presentation, preview an existing presentation or select a presentation to update, by adding new slides or by editing it through Presentation Editor.
3. Add slides to the presentation. During this step, the archaeologists search Museum database based on criteria like thematic entity, era, class, excavation site and museum's hall for the specific audience profile. The results can be viewed through a photo gallery, where the archaeologists can preview each exhibit's detailed information and add it to the presentation. The process of adding an exhibit as a new slide in a presentation is automatic. The generated slide contains exhibit detailed information like description, dimensions, weight, excavation site, era and bibliography, from the museum database [3]. An exhibit's photograph and a video (from excavation site or a documentary film, if available), are also embedded in the slide.

Through Presentation Editor, archaeologists are able to:

1. Edit and style slides' layout.
2. Add slides with static content that is not contained to Museum's exhibit database.
3. Save the changes to Museum's database.
4. Preview the presentation and project it to the specific audience (Presentation Projection functionality).



Figure 1 Authoring a new presentation from left-to-right.

## B. Presentation Synthesis

Through Presentation Synthesis, instructors or tour guides are able to create personalized presentations by using existing presentations. This functionality is provided by two tools: Presentation Creator and Presentation Editor.

Through Presentation Creator, instructors or tour guides can:

1. Define the audience profile by setting its language and type.
2. Search Museum database for desired presentations based on criteria like thematic entity, era, class, excavation site and museum's hall for the specific audience profile. They can also search the database for presentations containing specific words (text search). The results can be viewed through a thumbnail viewer, where the instructors or tour guides can preview the.
3. Select one or more presentations that are interested in and make a copy, where they can edit or present through Presentation Editor.

Through Presentation Editor, which is a limited version of archaeologist's Presentation Editor, instructors or tour guides are able to:

1. Remove slides of the selected presentation or reorder them
2. Save the changes to Museum's database
3. Preview the presentation and project it to the specific audience (Presentation Projection functionality).

## C. Presentation Projection

Presentation Projection is functionality offered to both archaeologists and group leaders (tour guides or instructors) through Presentation Editor. In case of a simple visitor, this functionality is offered through the Presentation Browser. Presentation Browser is a limited version of Presentation Creator graphical toolbox from Presentation Synthesis, providing the same search functionality. Visitors after querying the Museums database for desired presentations, they can preview each presentation, through a popup.

Presentation Projection improves exhibit's location service. Application's user (archaeologists, tour guides or instructors, individual visitors), can view the slides that are relative to Museum's exhibit database, of the desired presentation in two different modes (Figure 3): normal view and panoramic view.

In normal view the user can see a static slide containing detailed information (description, image, video, etc.) about the specific exhibit. Furthermore, in panoramic view the user can see a panoramic view of the Museum hall containing the specific exhibit and its relative position in space, along with its information. Through a button, the user can switch between the two modes.

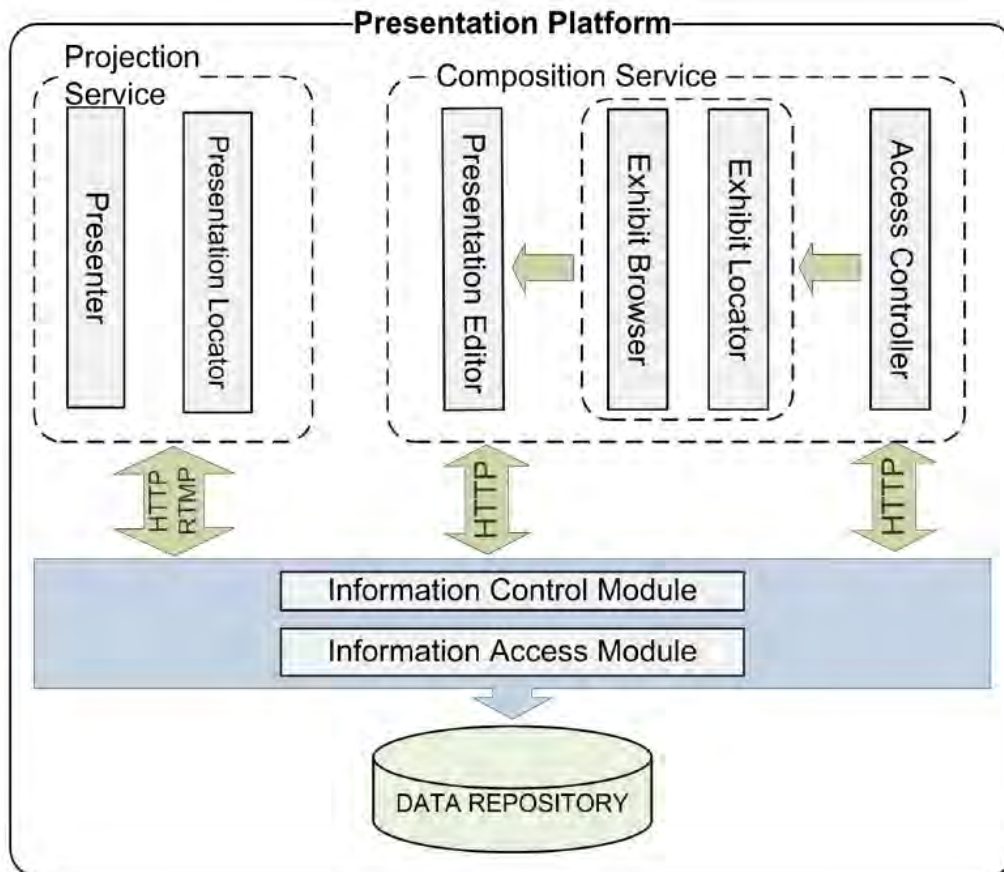


Figure 2 Platform's architecture

#### D. Presentation Room Architecture

Presentation Room is a web based application. Presentation logic is implemented in the client side. Platforms architecture's is depicted in Figure 2. Access Control is used to apply access policy and different functionality through web interface to user's group (e.g., archeologists, instructors or tour guides, visitors). Composition service queries Museum's database for exhibits based on audience's profile and search criteria (Exhibit Locator), preview artifact's information (Exhibit Browser) and edit or update presentations (Presentation Editor). Projection Service retrieves and displays presentations (Presenter) according to audience profile and preferences (Presentation Locator). The client-side of Projection Room was developed using the AJAX application model in combination with existing technologies (e.g., XML, CSS, XHTML, JavaScript, DOM, etc.). Ajax is a group of interrelated web-development techniques used on the client-side to create asynchronous and interactive web applications. Mootools [4] and MooFlow [5] JavaScript libraries were used in the development of the Projection Room application. An open source slideshow editor, named Slimey [14], was used as basis for the implementation of Presentation Editor. A custom extension of Slimey's SLIM, was developed to format slides and presentations.

In the server side, the database was designed to support multilingual, multimedia and multi-audience content and is hosted by MySQL database management system. The server application was implemented in PHP, runs on an Apache Web server and is comprised by two modules. The Information Control module handles: i) client requests, ii) authenticates users and informs Access Controller in the client side about their access level, and iii) implements business logic. The Information Access module performs database access. This last is the only module that requires modification in order to deploy the platform at another museum with different database schema.



### III.iMuse Mobile Tour

The iMuse Mobile Tour Application [6] [7] is a tour guide system. It utilizes UHF RFID technology to enrich museum visiting experience, through free style tours, pre-defined tours, interactive educational games and a group support service. The system supports multilingual and multiaudience content and it was implemented on a mobile RFID reader (UHF GUN) by iDtronic. The handheld device is a light weight computer with a touch screen, which uses an UHF RFID reader to recognize and distinguish the Museum exhibits. All showcases are equipped with RFID tags in order to link exhibits with the corresponding multimedia information stored to the museum's data repository. The tags were placed in non-visible positions, inside the showcases or behind informative signs, in order to insure museum's aesthetics. The position of the tags is indicated with a neat sign.

The operation of the iMuse Mobile Guide is based on handheld's integrated pistol grip. A short video presentation on the device screen illustrates the handheld's usage. Afterwards the visitor should set up his profile, by selecting his language and audience type. Currently, the information is available for adults, children and experts, in Greek, English and French. Children's profile provides simple descriptions made for kids, while expert's one provides access to more detailed information (e.g., bibliographic references related to the exhibits, etc.). Then, the visitor should level at the tag position of an item attracting his interest and pull handheld's trigger in order to acquire exhibit information (Figure 3). Its description, along with image, links to audio and video material as well as images of relative museum's items appears on the device screen. From the buttons on the bottom of the screen, visitor can switch between profile configuration, pre-defined tours navigation and games. Through the up down arrow buttons, as well as the right side bar, user can scroll through the exhibit's description.



*Figure 3 Visitor using iMuse Mobile Tour*

## A. Free style Tours

After the initial profile setup (language and audience type), visitors are able to explore the museum in their pace and retrieve information about any exhibit. Exhibit's information is composed of its photo and a short description (Figure), based on the visitor's profile configuration. During free style tour the visitor is able to change his profile setup, through the corresponding button on the bottom of the screen. The description comes also as vocal message activated by a button on the top of the display. The other two buttons on the top of the screen provide access to videos and photos related to the showcase. The videos are usually recorded in excavation sites. The photos are from excavations, individual artifacts in the showcase as well as related artifacts in museums store. Most of the photo gallery items are linked to additional more detailed information.

## B. Pre-defined tours

Mobile Tour contains a set of pre-defined tours in the museum, composed by the archaeologists to emphasize on a specific thematic entity of the museum. Besides the preset tours, visitors have the ability to create their own walks in the museum, using certain criteria according to their profile. The criteria include available time, class of the artifact (e.g., pottery, tools, coins, etc.) and era while experts can also select excavation site (Figure 4(b)). In both tour types, the route is drawn with a red line and the exhibits of interest are marked as green points while visitor's position is marked as a blue point (Figure 4(c)). Selecting a green spot, an image tooltip box is activated that presents information for the proposed showcase. Zoom functionality is also available, via a button on the top of the screen, to help visitors with Museum's arrangement. Exhibit's information (Figure 4(a)) is accessed like in free-style tours, by pulling the pistol trigger.

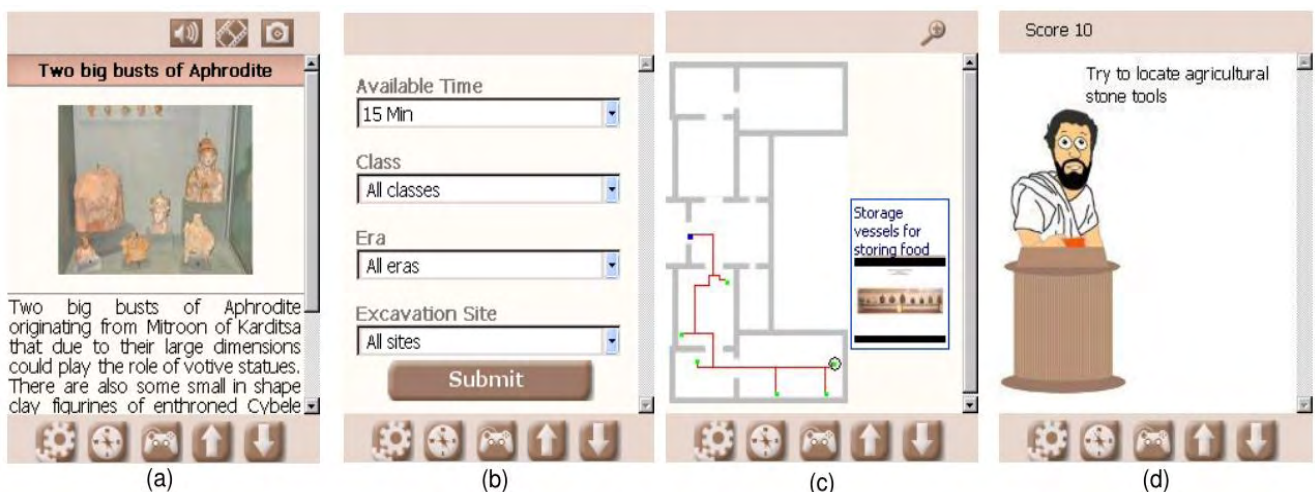


Figure 4 Mobile Tour screenshots

### **C. Interactive Educational Games**

Mobile Tour application includes a list of interactive “search and find” games, composed by a specialized to educational programs archeologist. Games describe activities that young visitors should accomplish by locating the relative showcase and scan it with the RFID reader (Figure 4(d)). In case of correct showcase finding, visitor is rewarded and the score is increased. In wrong answer, visitor is prompted with a hint in order to help locating the correct showcase. Games and predefined tours deal with the same subjects, and are used as alternatives education methods.

### **D. Group Support Service**

The group support service enables the delivery of exhibit information to the members of a group. The service aims to group of visitors equipped with a mobile guide device and pushes the accessed information to each visitor's private smart phone. The fact that the members of a group may have different profile (adults, children), moreover speak different languages (e.g. cruise ship tourists) restricts the concurrent usage of mobile tour from every group visitor without confusing. On the other hand, purchasing and maintaining a significant number of mobile devices so as they are available to each group visitor, is not affordable by the Museum. Group support service relies on a single mobile tour device used by the group leader, and on the features (high definition multi-touch screens, Wi-Fi network, g-sensors) of visitor's smart-phones and internet tablets to support learning in groups. The context-aware service pushes exhibit information that is accessed by a mobile tour device on group's private devices without any prior software installation. A typical usage scenario is as following. The leader of a group receives iMuse Mobile handheld by the information desk and enables group support service. He enters a nick name for the group and optionally a pin number. As soon as, group members join their smart-phones to museum's wireless network and open the web browser, a page with all available services is automatically loaded. Then, they can subscribe to group's service by selecting the nickname and providing the pin. The iMuse Mobile Tour device acts as group controller, exhibit information retrieved by it, is automatically loaded to the subscriber's browsers. Subscribers have the option to personalize information by changing audience type and/or language. Group's members, benefit by using their own up to date devices. Moreover, visitors may change their profile settings. This allows each group member to access exhibit information independently, customizing information presentation to his own preferences (language, audience type).

### **E. Mobile Tour Architecture**

Figure 5 depicts the client-server architecture of iMuse Mobile Tour. The client resides on the RFID reader and is developed in C#. The mobile application consists of three modules, the RFID Tag Identification module, the Request Information module and the User Interaction Control module.

The RFID Tag Identification module uses a .NET library provided by the handheld's manufacturer to configure and interrogate the RFID reader. This introduces a level of abstraction of the underlying hardware to the upper layers of the application. The Request Information module utilizes the retrieved RFID data and service information (e.g., server address and service's names) to format data requests for the server. Data requests are structured as physical hyperlinks and responses are received in html or xml. Specifically, exhibit information is structured in html, while metadata (e.g., types of multimedia available for an exhibit) are formatted in xml. The metadata are used to adapt user interface to the available information. User Interaction module is the core of iMuse Mobile client and is wrapped around a .NET web browser control. It implements application logic and handles user interface.

The server side application is developed using PHP and runs on an apache web server. It is composed by a request handling service and four tour aware services. Each one of the core services is comprised by two modules: the Control and the View module. The Control module implements the data access and business logic, and the View module deals with data representation. This software architecture pattern separates the representation of information from the user's interaction with it. The Request Control service (RCS) receives requests from the mobile devices and dispatches them to the appropriate service providing a single entry point to the server application. The Profile Control service (PCS) handles the user's profile (i.e., language, audience type, etc). It processes data fed by the visitor to set up his profile and line it to the other services. The Exhibit Information service (EIS) provides data and metadata on the exhibits. Data may include text, images, audio and video, while metadata specify the types of multimedia that are available to a particular artifact. Tour Coordination service (TCS) implements all required processes in order to maintain the guided tours. The Game service (GS) exposes a list of all the available games matching to user profile and dispatches the scenario of a selected game to the client. The game scenario, i.e., activities, relative showcases, and score, is wrapped in xml. The Group Support service (GSS) uses RFID data scanned by an RFID reader to push exhibit information to visitor's personal mobile devices following reverse AJAX design pattern. Only an AJAX enabled web browser is required on the visitor's mobile to access the service.

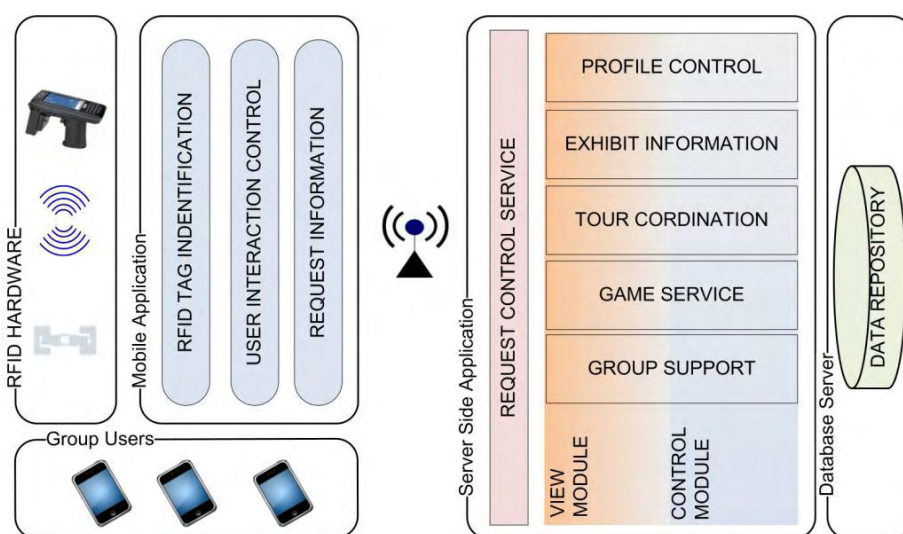


Figure 5 Mobile Tour Architecture

## IV. iMuse Virtual Wing

The iMuse Virtual Wing [8] is a multilingual, user-aware virtual museum environment that creates and presents a virtual representation of the museum, providing rich multimedia content (currently in Greek, English and French) through specialized filtering methods. The system provides a user interface to visitors for virtual navigation inside the Museum. The main characteristics of Virtual Wing application can be summarized in the following points:

- **Users in groups:** The platform supports three different user groups. Each user belongs to one of these predefined groups. This different approach divides system's users into groups based on age and knowledge background.
- **Feedback on the content:** Users are able to express their opinions on the exhibits they view, by rating or commenting them. Analysis on these user evaluations can lead to assessments on the exhibit's popularity for the different groups, where the users belong.
- **General Point of view:** Users are able to express their opinions about the system itself, through a number of questions, at the end of their visit.

### A. Group-based logic

Virtual Wing supports three distinct groups (children, visitors and experts) based on the combined characteristics of age and expertise. Depending on the group type, the system provides different interface and multimedia content to its users. In case of "children" category, the interface is more child-friendly and the multimedia content aims to raise the satisfaction levels of children and make them more interested in the tour and the exhibits. The existence of this type of group is based on the fact that nowadays more and more schools organize tours to museums, in order student to learn more information about their cultural heritage. In case of "visitors" group the multimedia content provides general information about the exhibits, since the users of this type of group do not have an in depth knowledge of history. More detailed information is available to the "experts" group, where its members have scientific background. Figures 6 and 7 depict the differences in user interface and content presentation when the same item is shown to a child and an expert. As it is clearly depicted in two figures archaeological content is more detailed in case of experts (item height, diameter, girth, class, material, excavation site, bibliographic reference) while the same information provided to children is adjusted to their knowledge and comprehension capabilities. Moreover, children's interface is designed to attract their interests through vivid colors and larger size fonts.

## B. User Monitoring

Apart from the functionality of content presentation, Virtual Wing also contains a user monitoring component which is responsible for capturing user feedback and extracting user preferences. The user monitoring component is composed of four different mechanisms: questionnaires, ratings, page-hits and comments in order to collect appropriate data from visitors and dynamically adjust the presentation content to next visitors. Questionnaires are a number of general questions given to the users at the end of the tour in order to measure the user's satisfaction level and provide feedback to museum administrators for future improvements. Ratings, comments and page hits are used to automatically calculate the most popular item for each group, depending on previous visitor's preferences. Through a scaled rating system of 1-5, users can evaluate exhibits and comment individual items. Simultaneously, the system detects user's interests, by tracking the page hits of the visited exhibits during visitor's navigation. In order to find the most popular list of items, the algorithm assigns a popularity score to each item, based on its total number of comments, overall rating and page hits. The formula gives greater weight to comments since commenting an item requires more time and effort and therefore can be considered as an evidence of stronger interest than rating or simply visiting an item.



*Figure 6 A clay vessel artifact presented to a child*



Figure 7 A clay vessel artifact presented to an archaeologist

### C. Virtual Wing Architecture

Virtual Wing is based on the development of dynamic web pages using HTML, PHP and Javascript. Figure 8 provides a quick review of system's architecture.

- **User Preferences:** Initially visitors should set their language (currently in Greek, English and French) and their audience type (children, visitors, experts), through the “Select Language” and “Select Audience” view, respectively. Depending on user settings, Virtual Wing provides different user interface with appropriate content.
- **Room Selection:** The “Room Selection” view allows users to select a museum's room in order to virtually navigate. After the selection, users are virtually transferred to a new screen that shows the plan of the room.
- **Plan of Room:** That screen presents the plan of the selected room in a panoramic view with the enclosed showcases. Bellow the plan of the room, there is a number of filters (Material, Class, Era, Site and Rating) for the available showcases. The resulting showcases of the filtering process are highlighted in the panoramic view of the room. Through a “Reset” button users are able to return to previous state and make new search queries.
- **Showcase Navigation:** This is the “Preview Showcase” popup window, containing the picture and a short description of the selected showcase. Through the “Go to Showcase” button visitors can navigate to the selected showcase and get more detailed information.

- **Showcase:** This view is divided into three parts. The center part contains an image of the showcase and a detailed description, according to user’s initial preferences (language, audience type). On the left side of the screen there is a list of available multimedia content (images, audio and videos) related to the selected showcase. On the right side of the screen there is a scrolling list of the available items of the showcase, where the user can get detailed information by selecting the desired item.
- **Item:** This screen has almost the same layout as the “Showcase” view, containing detailed information about the selected item. Furthermore users are able to rate (scale of 1-5), comment and get information about the excavation site of the item with the corresponding buttons. User’s comments are moderated by the museum administrators. The right side of the screen contains information relative to the specific item (length, width, height, diameter, girth, class, material, era, excavation site)
- **Excavation Site:** This view contains information about the excavation site where the respective item was found.
- **Standard Options:** It is the panel that exists in all screens and contains the following buttons: Go Back, Go to the Start, User Manual, End of the Tour

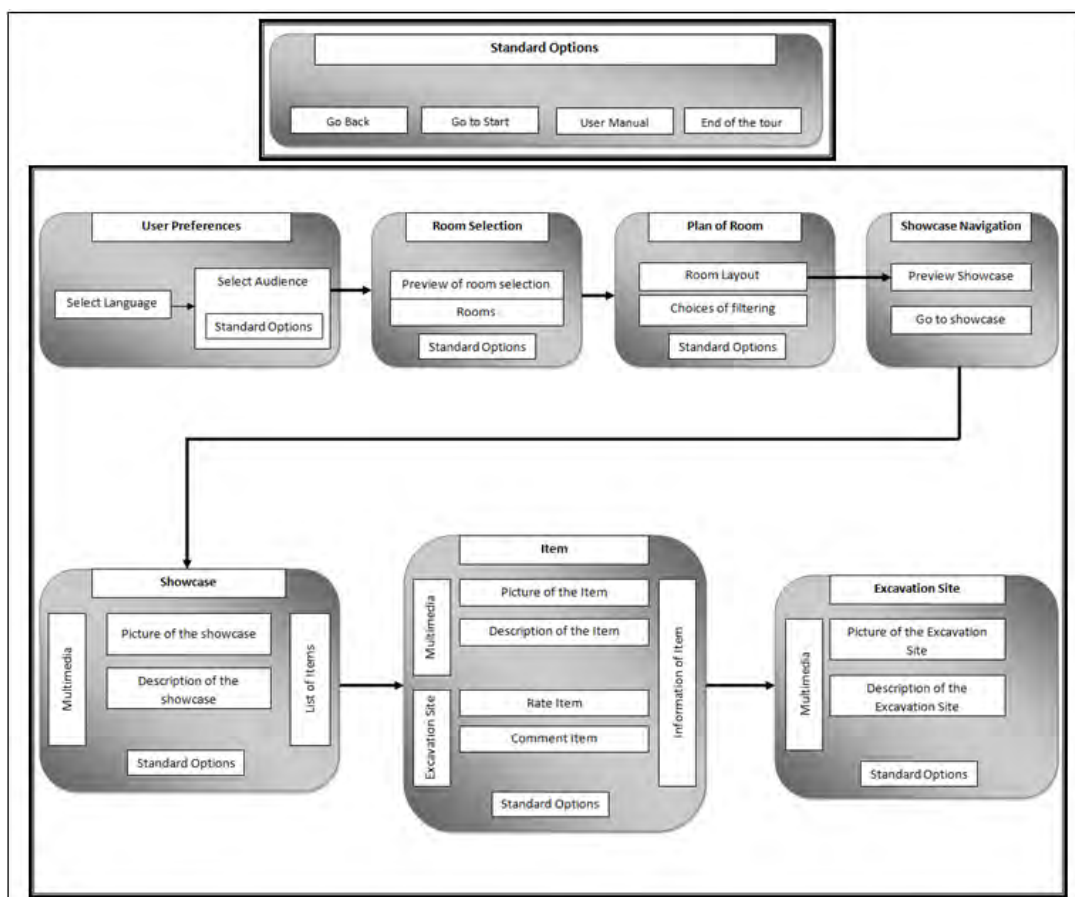


Figure 8 Virtual Wing Architecture



## V. Technologies for Accessing Cultural Data

Museums have increasingly been joining the global movement for open data by opening up their databases, sharing their images and releasing their knowledge. Cultural data is data about exhibits providing detailed information about publications, bibliography, length, width, height, diameter, girth, class, material, era, and excavation site. There are a number of technologies that can be used to provide accesses to museum's cultural data.

Web conference systems can be used for live presentations of cultural content via internet. A typical web conference system may support slide presentations, live audio and video streaming, desktop sharing, text chats, etc. Adobe's Connect [9] and Cisco's WebEx [10] are commercial representative products and Openmeetings [11] is a full-featured opensource alternative.

Online office suite platforms can also be used to deliver educational content in the form of slide show. They can be accessed online from any Internet-enabled device running any operating system. Google Docs [12], Microsoft Office Web Apps [13], Zoho [14] are fully featured online office suite systems, offered by websites in the form of software as a service (saas). These web applications allow users to access their documents within a web browser and collaborate with other users online. Feng Office Community Edition (formerly OpenGoo) [15] is an open source collaboration platform that can be downloaded and installed on a server. The document management feature of the above platforms can be used to create and edit online documents and presentations.

Web presentation systems are online platforms that enable users to create, manage and share slides. Several frameworks and tools have been designed and developed in this area. S5 (Simple Standards-based Slide Show System) [16] is Eric Meyer's open source slide show format, based entirely on XHTML, CSS, and JavaScript. S5 slide show package works in all modern browsers without any plugin since it includes its own slide show machinery in JavaScript. S6 [17] started as a rewrite of S5 using the jQuery JavaScript library, offering easier to understand and easier to extend code. HTML Slidy [18], similar to S5 from W3C, is a Web-based tool for creating, presenting, and viewing slideshows. Each presentation is a single XHTML file and each slide is enclosed in a `<div class="slide"> ... </div>` element. JavaScript is used to control the presentation by hiding or showing the div elements, while CSS is used to control the appearance of the presentations. Slimey [19] is an open source web-based slideshow editor, built as part of the OpenGoo project. Slimey uses the SLIM format (Slideshows Microformat) which is an extension of the S5 format. Its functionality includes: insertion and removal of text, images and bulleted lists, addition, removal and reordering of slides, undoing/redoing, changing font face, font color and font size of elements, text formatting (i.e., bold, underline, italics), viewing source code, previewing and saving presentation. Slideshow (S9) [20] is a Ruby package that enables the creation of slide shows and authoring slides of plain text using a wiki-style markup language (Markdown [21], Textile [22], reStructuredText [23]); the generated slideshow can be accessible through any web browser. Slideous [24] is a lightweight HTML Based Presentation Tool, inspired by S5 and Html Slidy. Popcorn [25] is an HTML5 media framework written in JavaScript that allows video, audio and

other media to control elements of a webpage. The framework can be used to create time-based interactive media on the web. The Popcorn JavaScript Library is part of Mozilla's Popcorn project.

SlideRocket [26] and SlideCaptain [27] are representative commercial cloud based presentation systems with advanced features.

Cultural heritage presentation systems can exploit the recent advances in smartphones industry. NFC (Near Field Communication) technology can be used for the creation of mobile applications to provide information to visitors during museum visits, making exhibits interactive and personalized. NFC is a short-range high frequency wireless communication technology that enables the exchange of data between devices in short distance. The underlying technology behind NFC is the same RFIDs, which has been used for decades now. The mechanism allows NFC enabled devices to establish connection when they are brought closer to each other. The market for NFC-enabled mobile phones reached a breakthrough in late 2011 and accelerated further in 2012 as new NFC handsets were introduced by all leading handset vendors.

There are three different solutions for smartphone development: native, Web and hybrid. Native apps are built for a specific platform with the platform SDK, tools and languages, typically provided by the platform vendor (e.g. xCode/Objective-C for iOS, Eclipse/Java for Android, Visual Studio/C# for Windows Phone). They are installed through an application store (such as Google Play or Apple's App Store) and can take full advantage of all the device features (camera, GPS, accelerometer, compass, the list of contacts). Native apps can also use the device's notification system and can work offline. Web apps are server-side apps, built with any server-side technology (PHP, Node.js, ASP.NET), written with web technologies (HTML5, CSS and JavaScript) and render via a Web browser. Although Web apps look and feel like native applications, they cannot take advantage of the available device features such as the notifications running in the background, accelerometer, camera and complex gestures. Hybrid application is the combination of native application and a Web application. Like native apps, they live in an app store, run on the device and can take advantage of the available device features. Like web apps, they are written with web technologies (HTML5, CSS and JavaScript).

## VI. Cultural Information Systems

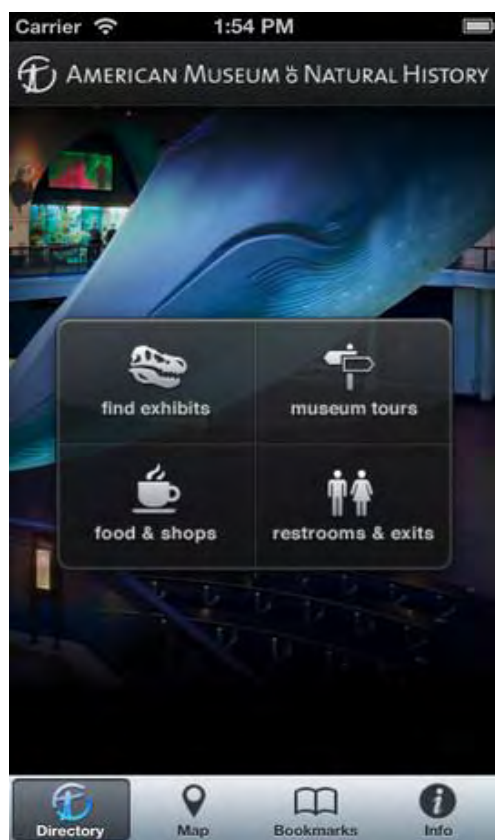


Figure 9 Explorer main menu



Figure 10 Explorer Popular exhibit's list

Tsai and Sung developed a mobile application explorer [28] for the American Museum of Natural History. The AMNH Explorer (Figure 9) is a custom navigation system and a personal tour guide for the Museum. The application is compatible with iPhone, iPod touch, and iPad. The application is designed to help visitors find their current location within the Museum and navigate using the digital floor plan (Figure 12). Visitors can get information about selected items from the Museum's vast collection during their visit or browse exhibits from anywhere in the world (Figure 11). The application provides turn-by-turn directions to exhibits or anywhere else (e.g. food & shops) in the Museum using the quickest route. Visitors are able to choose from a variety of Museum-designed tours (pre-loaded tours) or create their custom tours from a list of popular exhibits (Figure 10), specimens, or artifacts. Another feature of the application is the fossil treasure hunt, where visitors use clues to find specimens and exhibits in the Museum's fossil halls. They are also able to share their adventures with friends and family by linking directly to their Facebook and Twitter profiles or through email. Visitors can bookmark an interesting exhibit and receive a link to more information after their visit. After downloading and installing the application, visitors can discover

the Museum's must-sees from anywhere in the world, plan their next visit, see opening times and directions to the Museum plus information about key events.

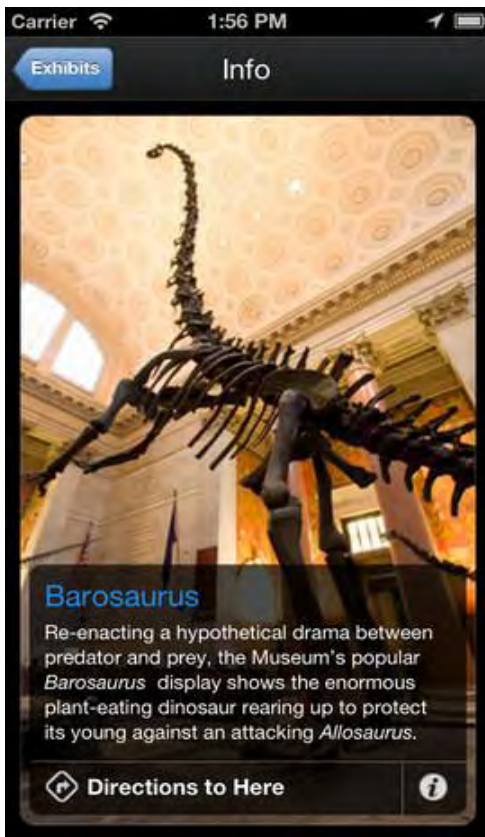


Figure 11 Explorer Exhibit's details



Figure 12 Explorer digital floor plan

An automatic personalized exhibition recommender-assistant is presented in [29]. The proposed system has been deployed and working in the Museum “Digital Exhibition of History of Olympic Games in Antiquity” in Ancient Olympia (Greece, EU). The application is designed to help navigation within the museum, via a properly customized portable device. The museum is physically divided in 14 exhibition halls and thematically divided into 12 thematic sections. Each section has from 1 up to 4 thematic keys. The term “keys” includes extra information (it can be regarded as a sub-unit) that is available to the visitor after watching the content on a specific section chosen. The automatic personalized assistant has a novel system for identifying and presenting the position/location of each visitor in the wide area of the museum (Figure 14). The positioning is based on two interconnected wireless Wi-Fi 802.11g network infrastructures (one within the 14 exhibition halls and a second outside and around the museum), the topology of exhibition halls and the wireless network card of the PDA. There are two different types of operation for the application: automatic and manual. In automatic operation, visitor's position inside the museum is automatically identified using Wi-Fi network and the equivalent multimedia data is presented to him/her. Moreover, the visitor has information on the position of his family and/or his friends in the museum (Figure 15) as the tour assistant has the possibility of establishing a group of tour members move

independently if they wish. In manual operation, the user can choose directly the multimedia presentation that wants to watch, independently of his/her position in the museum. The system supports three different types of presentation: audio tour (contains only an audio presentation on the thematic sections), detailed audio tour (contains only an audio presentation on the thematic sections and the keys) and audiovisual tour (contains an audiovisual presentation on the thematic sections and the keys) (Figure 13). The presentation's content is available in four languages (Greek, English, German and French) and the application is designed to support more languages depending on the needs of the Museum. In addition, the tour assistant supports mobiles instant messages between visitors in the same group of users (Figure 16). Also, every user is able to receive information messages from the museum information desk, through a specially designed Monitoring and Management Visitors Administration Console.

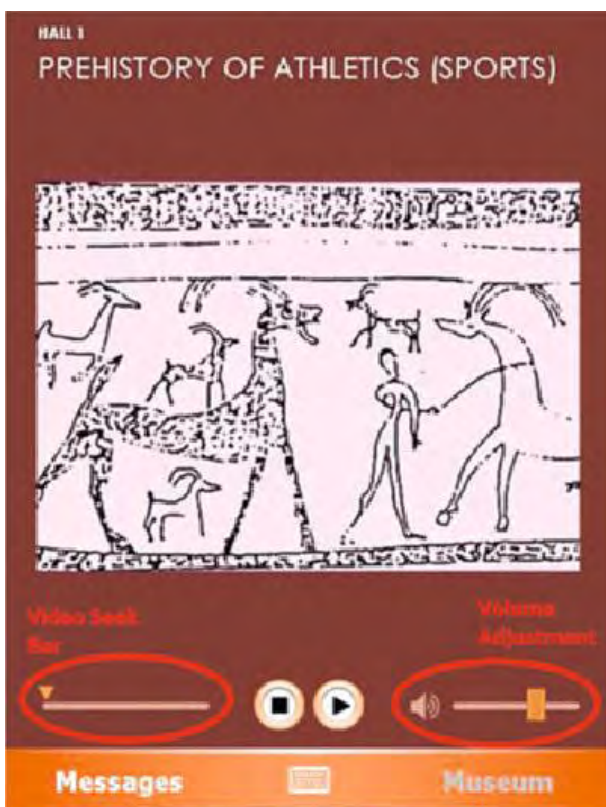


Figure 10 Audiovisual tour playback



Figure 14 Museum map

Museum Guide [30] is an indoor location based, context aware, and video on demand mobile application, developed by Jaegeol Yim and Thanh C. Le. The indoor location based service (ILBS) is based on the museum's wireless network infrastructure. The Museum Guide is a mobile application that can detect whether the user is moving or not, by investigating 10 recently gathered accelerometer values from the smart-phone. It can also detect whether the user is watching at an exhibit or not. The user aims at the exhibit with his or her phone camera when the user is interested in the exhibit. This situation can be detected by investigating pitch value. Once the user is

determined to be watching an exhibit, Museum Guide identifies the exhibit being watched by the user and plays the video which is mostly relative to the exhibit. The guide has two recommendation modules, one for showcases and the other for videos. For the recommendation system, the database is corresponding to the dataset in Movielens. The recommendation module finds the entries (similar subscribers) which are the most similar to the user (the owner of the smart phone). Then, it returns the videos or showcases (most likely visited showcases/videos) that have been most frequently visited by the similar subscribers. The recommendation module considers two persons are the most similar if all the attribute values (gender, Zip Code, hobby, occupation, age) are the same. Two persons are considered as the second most similar if the values of gender, age, hobby and occupation are the same. Finally, two persons are considered as the third most similar if they share the same hobby. The recommendation module takes also the available time into account. That is, by investigating the current time and the scheduler of smart phone, it estimates the available time for which the user may spend in the museum. Considering user's available time, it recommends appropriate number of showcases/videos from the most likely showcases/videos. In case the user selects a video from the list of recommended videos, the smart phone starts playing the video. The video player is interactive in that if the user touches an object on the screen then the player pauses playing the current video and starts playing another video that is associated with the touched object. The application manages history and rating data, by recording information about "who and when watches which video" and "who rated which video what level" in order to update database's entries.



Figure 15 Contacts, positioning information and incoming notification bubble



Figure 16 Mobile online chatting

A museum guide application for three major mobile platforms (iOS, Android, Blackberry Tablet OS) is described in [31]. The proposed system has been tailored around the offerings of the National Archaeological Museum of Athens (Figure 17) and its main purpose is to escort users during their visit, offering guidance and information. QR codes were adopted to provide information about user's current location. Each accessible building area and each individual exhibit within the museum has been assigned a QR code. Through the use of device's built-in camera, a user can inform the application of his/her current location. This method can also be used to identify an exhibit and provide information about it. Exhibit's information is composed of its description, additional multimedia content and extra details (e.g. material, date found, origin, periodisation, etc.) The system supports free navigation through a fully interactive map, that supports touch-enabled zooming and panning functions through pinching and dragging gestures. Visitors are able to select any particular Point of Interest (e.g. room, exhibit) on the map and get detailed information on device's screen. They can discover routes to different locations within the museum by simply providing the starting and the ending point. The application will calculate the most convenient path and display it on the map, including appropriate instructions where the floor level may need to change. Visitors are also able to choose from a set of Museum-predefined tours, depending on their available time (Figure 18). The guided tours are passively location aware, by asking the user to confirm his/her location in the room, using the QR code identification method. In more detail, when a user states his/her location, the map centers to the respective room and virtual pins that correspond to the exhibits that belong to the selected tour are displayed to facilitate their detection in the physical room. If the user decides to deviate from the predefined tour the application will comply, supplying any requested content along the way; in addition, it offers the options to either return the user to the last visited point, or simply continue the navigation from the nearest not yet visited exhibit that belongs to the tour. Visitors are able to search for a specific exhibit and get detailed information about it. They can select and add exhibits to their favorites, from where they can later create a new personalized tour depending on their preferences.



Figure 17 Museum Guide main menu



Figure 18 Museum Guide short tour

A system that can help visually impaired people to tour inside a Museum, through mobile and NFC technology is presented in [32]. The solution proposed has been tested in a real environment: the Baena Olive-Grove and Olive Oil Museum, receiving a good acceptance from the users. At the entrance of the Museum there is smart poster with a map of the Museum. Each room that appears in the map has an RFID tag with information about how to get there (Figure 19.1). When a user interacts with the map, a vibration is displayed to help him to get to the tag, later and depending of the user preferences stored in the mobile device, the phone will play a reproduction indicating the room, how to get to it and a set of advices, i.e. if the user will have to climb stairs, to take a lift or to pass through a door. At the entrance of each room a smart poster has been placed. When the user brings his mobile device close to the poster, the device vibrates indicating that a tag has been found and plays a recording with information of the room. The same process takes place inside each room with the main objects. Each object has a tag with some information. This information is played by the NFC mobile device to the user (Figure 19.2). The system can also be used by visitors with no visual impairment. In that case, the user can change the display mode of the information from audio to visual, in the preferences of his/her mobile device.





Figure 19 Some snapshots of the NFC interaction in the room “El Molino”

A multimedia mobile guide for the visitors of the Wolfsoniana museum of Genoa is presented in [33]. The objective of the system is offering visitors a novel and immersive experience when visiting the museum. Through Near Field Communication (NFC) and Quick Response Code (QR Code) technologies, visitors can interact with the surrounding environment using their own devices, e.g. smartphones or tablets, receiving personalized multimedia content as they move inside the museum. The system is composed of a network infrastructure, including the installation of RFID passive tags and QR Codes, and a mobile application available for both Android and iOS platforms. At the entrance of the museum a smart poster illustrates visitors how to connect to the local Wi-Fi and install the application on their own device. The first time the application is launched visitors can set their profile indicating nickname, age and language and start navigating inside the museum. This allows the system to provide content for different types of users. By approaching the NFC-enabled smartphone to the RFID tag, visitors can access multimedia content composed of in-depth analysis, photos, videos and audio related to the exhibit (Figure 20). In more details, the RFID passive tags and QR codes contain a unique code that triggers a server to provide detailed information to a specific tagged exhibit. For devices without NFC, the smartphone’s camera is sufficient to scan the QR Code in order to have access to exhibit’s digital content. Visitors owning an NFC-enable device are able to switch at any time between the two modes (RFID tag reading and QR Code scanning). Visitors can leave feedbacks and comments about the visited exhibits, taking actively part to a social experience inside the museum. Through application’s interactive map, visitors can see the location and the number of the exhibits already scanned.

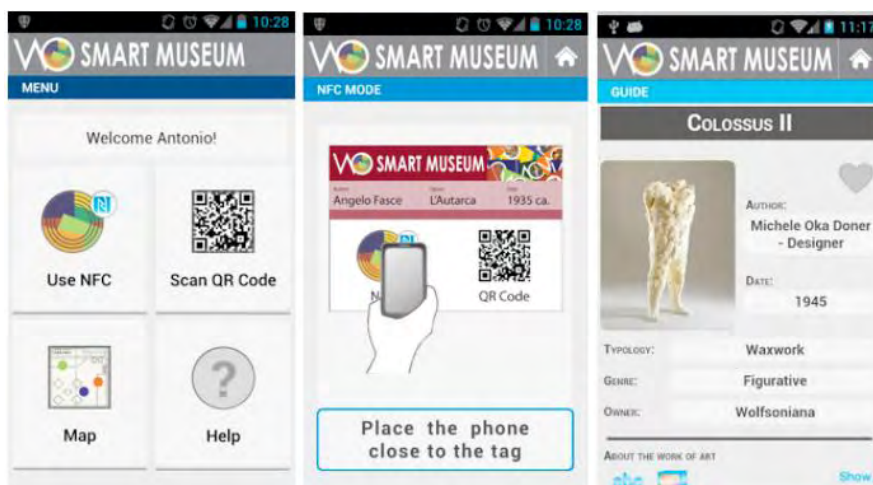


Figure 20 Screenshots of the Wolfsoniana App illustrating the NFC mode.

The CHIP (Cultural Heritage Information Personalization) project [34] [35] [36] offers online and mobile tools to the visitors for virtual navigation inside the Rijksmuseum in Amsterdam. The main objective of the CHIP project is to demonstrate how Semantic Web and personalization technologies can be deployed to enhance access to digital museum collections. Visitors are able to browse the online collections, plan personalized museum tours, get recommendations about interesting artworks to see, rate exhibits and navigate inside the museum. The Chip project is composed of three components/tools: Online Art Recommender, Online Tour Wizard and Mobile Museum Guide. The online Art Recommender (Figure 21) is a Web-based rating dialog for artworks/topics that helps visitors to discover their art interests in the Rijksmuseum collection and to store them in a corresponding user profile. Through a photo gallery, visitors are able to explore museum's artifacts and update their preferences. The online Tour Wizard (Figure 22) is a Web-based tool, used to generate online (semi)automatically personalization virtual museum tours containing recommended artworks according to the user's interests, based on the profile created by the Art Recommender. Via the map provided by the Tour Wizard, visitors can display the location of selected exhibits inside the museum's halls. The mobile Museum Guide (Figure 23) is a PDA-based tool that converts the online created virtual tours with Art Recommender and Tour Wizard to on-site tours on the mobile device and guides visitors in the real museum environment. Visitors can access extensive description of each artwork, as well as a set of related artworks to the ones included in the tour or any given one in the museum. They can dynamically adapt their tours by expressing in terms of ratings preferences in some seen artworks, or by indicating a desired tour length or number of artworks to be included in the tour.



Figure 21 Chip online Art Recommender



Figure 22 Chip online Tour Wizard



*Figure 23 Chip mobile Museum Guide*

Google Art Project [37] is an online platform through which the public can explore museums and works of art. The project was launched on 1 February 2011 by Google, in cooperation with international museums. The platform now features more than 32,000 artworks from 46 museums and the ultimate goal is to reach 150 museums from 40 countries. Google Art Project enables users to access high-resolution images of artworks and navigate using the “walk-through” feature (Figure 24), which has similar functionality to the Street View from Google Maps. The images of many of the artworks were reproduced with very high quality, and each partner museum selected one artwork to be captured as a gigapixel image (with over 1 billion pixels). From the Gallery View, users can zoom in on a particular artwork to view the picture in greater detail. Users can click on the “Details” button to find out more information including dimensions, biographical information about the artist, specific details about the work, or a critic’s note (Figure 25). The amount of information depends on how much the museum has provided for any given piece of art. Users can also create their own collection and share it with others, through social media and conventional online communications mechanisms, using their Google Account and Google’s applications. Through the “Explore and Discover” component users are able to search across numerous collections, using a number of filters including: artist, museum, type of work, date, and country. In addition to sharing the artworks, museums have also shared narrated videos, audio guides and viewing notes. The main purpose of Google Art project is to make all of this information available to the public, through a web based interface.

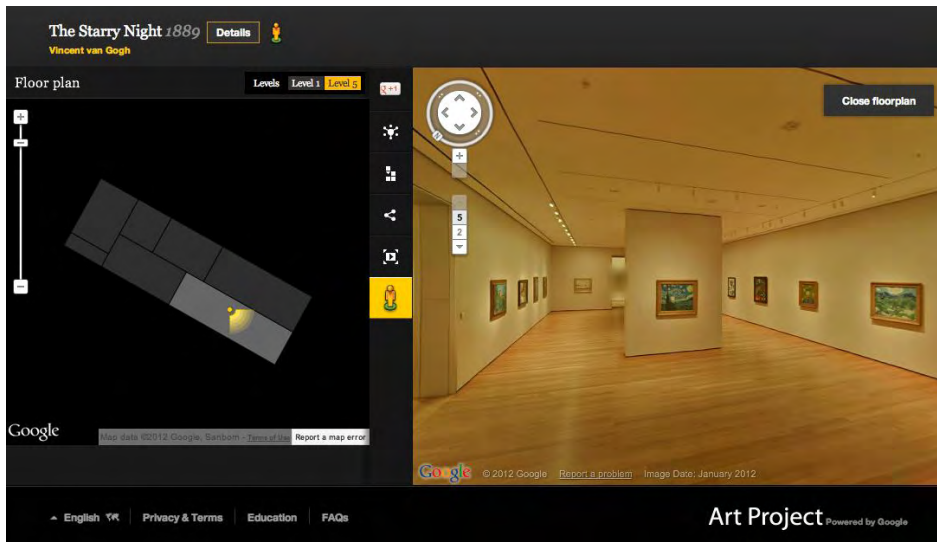


Figure 24 Google Art Project Floor plan and “walk-through” feature

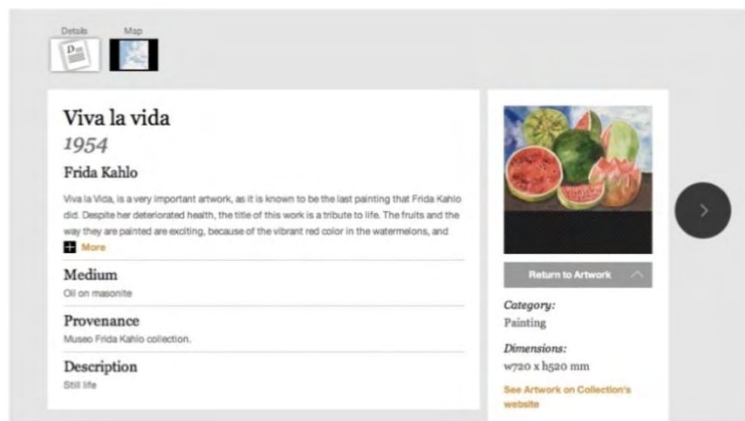
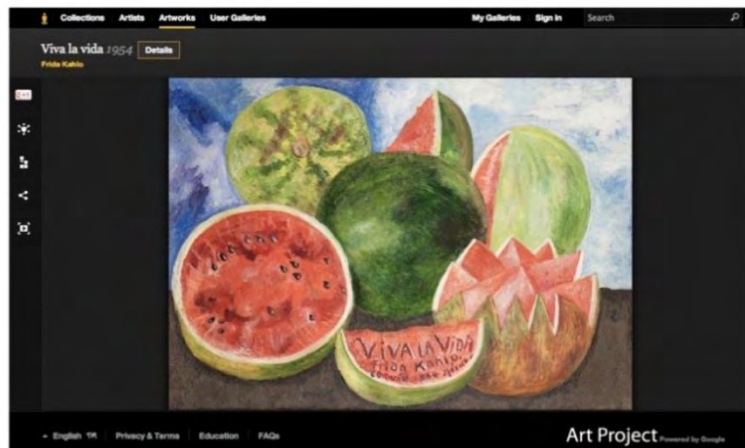


Figure 25 Google Art Project painting details

## VII. Conclusion and Future Steps

Concluding, several museum information systems providing access to cultural data in different ways were presented. Special attention was given to the iMuse virtual museum over a sensor's web. The system has been deployed in Archeological Museum of Volos and its main purpose is to enrich museum visiting experience and support museum's educational programs, through the use of three components: Mobile Tour, Presentation Room and Virtual Wing application. This new type of Virtual Museum is based on Web, Sensors (UHF RFID) and intranet technologies in order to deliver multimedia content related to museum's exhibits. The iMuse Mobile Tour is a mobile museum guide application providing predefined and self-defined tours as well as interactive games to stimulate learning. Through the group support service of the Mobile Tour application, group visitors are able to exploit guidance services on their private mobile phones. The iMuse Presentation Room is a web platform for delivering multimedia presentations on cultural heritage. The main purpose of the application is the generation of rich media (text, images, video and sound) presentations considering the personal profile of the audience as well as its interests. The iMuse Virtual Wing is a user-aware virtual museum environment that can help visitors navigate virtually through the museum's exhibits. Apart from the virtual representation of the museum and the delivery of detailed information related to museum's exhibits, Virtual Wing also contains a user monitoring component which is responsible for capturing user feedback and extracting user preferences.

Although iMuse has already reached a satisfactory level of maturity, there are plans for the addition of more features. In particular, one of the current development priorities is the implementation of the Mobile Tour application's features for NFC-equipped smartphones. The process involves the development of an application for different mobile operating systems (Android, iOS) and the installation of NFC tags in the museum's showcases. Some museums around the world such as the Museum of London, The National Museum of Korea, the musée du Quai Branly in Paris and the Wolfsonian museum of Genoa are employing NFC-based guide services. The best approach for the development of a cross-platform app for NFC-enabled smartphones, providing the features of the Mobile Tour application, is the use of the hybrid model. The hybrid app can have access to native features such as the device's notifications and the build in NFC module. The development costs can be reduced in the way that the same HTML5 and Javascript code components can be reused on the different supported mobile operating systems (Android, iOS). Furthermore the group support service of the iMuse Mobile tour could be implemented as a web application providing cross-platform functionality at low development cost. The requirements of the group support web app are low in the meaning of using the smartphone features and graphics performance.

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- c) A team of archaeologists from 13th Ephorate of Prehistoric & Classical Antiquities, headed by Dr. Argyroula Doulgeri-Intzessiloglou, A' level Archaeologist and Director of 13th Ephorate of Antiquities.

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