

VISITING ARCHAEOLOGICAL SITES WITH OUR MOBILE PHONES: THE AGAMEMNON PROJECT

C. Bottaro^a, A. Traverso^b, M. Ancona^c

^aDARFICLET, University of Genoa, via Balbi 4, 16125 Genova, ITALY - ijas.ge@libero.it

^bDARFICLET, University of Genoa, via Balbi 4, 16125 Genova, ITALY - antonella.traverso@lettere.unige.it

^cDISI, University of Genoa, via Dodecaneso 35, 16146 Genova ITALY – ancona@disi.unige.it

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ABSTRACT

The main originality of the Agamemnon Project research is the idea to identify the pictures taken of monuments by visitors with their phones cameras, and to provide them with enriched and personalized information directly on the phone.

Experimented at the very important archaeological sites of Paestum (Italy) and Mycenae (Greece), the prototype will be able to suggest a optimal – but not fixed – visit path and profile the visitor's level of knowledge/interest, identifying three "language" types, fit for the different visitors categories. During the visit, the system will recognize the pictures taken at any time by the visitors and deliver reach multimedia information such as audio and video clip, 3D reconstructions, texts, etc. It will be also possible to optimize the flow of visitors to avoid overcrowding of the most popular points of interest.

Because of its great attractive potential Agamemnon is expected to create a relevant additional revenue stream for the sites, with very limited investment and offer a cheap tool to monitor the status of conservation of the monuments, by recording all the pictures taken in a "monitoring system" which will be at the site guardians disposal.

1. INTRODUCTION

This paper shows the goals and the first results of the Agamemnon Project, founded by the VI European Framework Program for Research (January 2004-June 2006). The Agamemnon Consortium is composed of Italian, Greek and English partners. The leader partner is the Italian society TXT e-solutions SpA, a leading company in the market of computer solutions for e-business and for Supply Chain and Customer Management; the software architecture design will be also trust with the English society MJC2 (specialized in software design of complex scheduling systems as well as mobile software systems) and the Greek society ANCO S.A. (Telecommunications, Electronic Testing and Measuring Instruments, Power Supplies, Steel and Iron products). The university of Genoa (Italy) contributes with two different departments: the Department of Informatics and Computer Science (DISI), in charge of the image processing, and the Archaeology and Philology Department (DARFICLET) in charge with the public analysis and profiling criteria, messages construction methodology, dissemination activities. These partners have already worked together on the research project PAST, Experiencing Archaeology Across Space and Time (IST-1999-20805), aiming at offer a fixed guided visit by means of palmtops placed at visitors disposal by the archaeological sites management. Now, due to the advances in 3G cellular phones with imaging and multimedia capabilities, the most recent communication and information technologies have been considered the promising new perspective in which address the three main challenges of cultural heritage management on global scale: valorization, cultural mediation, preservation. For these reasons, two of the most important European archaeological sites have been involved as partners for the experimental phase: Paestum (Paestum Foundation, Italy) and Mycenae (4th Ephoria of Prehistoric and Classical Antiquities, Nauplion, Greece). They are in first place both in the national and international archaeological panorama for the importance of the finds and the condition of the monuments ad attract every year a very high influx of visitors from all over the world (400,000 - 500,000 on average). They represent optimal "test cases" due to their structural and archaeological differences.

For example, Paestum offers the possibility of various visit paths, because two different admission gates allow to enter the vast sacred area (about 10 hectares) with the three wonderful doric temples. On the contrary, the typical visit path in Mycenae is represented by one preferred route that starts from the Lion Gate and includes the Acropolis, as well as touching the Grave Circles (i.e. the famous Agamemnon tomb, the Treasure of Atreus, etc.). Moreover, the different status of conservation of the archaeological remains allows to test a wide range of requests of information from the visitors.

The following sections illustrate, after a summary on the cultural tourism state of the art, the main targets the Project aim to get and the first results achieved, together with an overview on the technical features and the benefits derived by the system.

2. CULTURAL HERITAGE AND TOURISM

The cultural tourism is becoming one of the largest industry in the world. In most parts of Europe 90% of the visitors don't come from the same town where the museum or the site is, but they are occasional public who come from other towns or countries (Solima 2000). The conclusion is very meaningful: the most part of the public, today, visit cultural heritage for tourism, during their free time, looking for entertainment (Richards 2000).

It has been confirmed that over 70% of visitors to museums can be put into the ambit of "cultural tourism" or, in other words, the field into which streams of people have a journey, usually in small family groups or group tours, with the principle aim of understanding the art and culture phenomenon of past civilizations. This type of tourism represents about 40% of the global holiday market; the duration of the stays generally floats from a day in the medium/large centers to at least three days in the major cultural capitals. It is however certain that 67% of tourists who fall into the "cultural" category devote no more than seven days for their holiday. Here we can therefore outline some points about the behaviour of the cultural tourists:

- a) they visit a site/museum during the holidays and, most probably, once in a life
- b) they visit the site/museum for entertainment

- c) they have limited time to visit the site/museum
- d) they need easy and fast instruments for localize and understand the archeological remains.

In recent studies on the public of museums is confirmed that the public visit the museum/site for distraction or enjoyment (Rieu 1988, Solima 2000, Richards 2000): therefore the cultural heritage must be a place of discovery, into which the “time” variable has a very important role. Normally, a tourist to a foreign city or archaeological site has a limited period of time at his disposal, into which he can visit only the most important museums and monuments. Therefore the choice is generally determined by the universally known formula of the “experience that cannot be missed” for its exceptional content. Obviously from these cultural products the consumer will expect the best and more exhaustive message in the shortest time as possible.

For these reasons, it is no accident that the tourist exploitation of cultural heritage is likely to become one of the more promising fields of application for the new information and communication technologies. These instruments allow to answer better and better the new needs of the cultural tourism: communication efficacy, quickness, ease of utilization.

From these assumptions, to turn the research in cultural communication towards the third generation cellulators with multimedia capability and integrated fotocameras, seems to be very promising, in particular in Italy where one of the largest concentration of the world of cultural goods and archeological sites is combined with a big expansion of cellular phones market (today third in Europe).

The Agamemnon Project fits in this context, and its primary purpose is to put historical and cultural information at visitors of archaeological sites disposal, by means of an intuitive and innovative way: their own last-generation phones, equipped with integrated digital camera and capable of playing videos and pictures, will be changed in an interactive and personalized guide.

3. THE AGAMEMNON SYSTEM MAIN FEATURES

3.1 General Overview

The Agamemnon system exhibits a number of characteristics that make it far superior to a conventional paper guide.

The distinguishing feature of this service is that the visitors can, at any time during the visit, take a picture with their phone camera to some object attracting their interest and send it by means of the UMTS network to the server, what will identify it and answer with enriched and personalized multimedia contents directly on the phones. Before start the visit, therefore, the users are invited to provide a set of personal information in order to establish the “visitor profile”, according to which different types of communication languages and contents are selected: this will avoid problems about comprehension of the information proposed.

At the same time the system will contribute to optimize the visit path suggesting the visitor an ideal but not fixed route, fit most of all for the “budget” time and the level of interest. The user is, at any time, free to change or even ignore the proposed path. By means of the capability of scheduling the visit, it will also possible to offer a “crowd avoidance” service, when large numbers of visit paths are simultaneously planned, notifying the visitor what monument are at that moment most overcrowding. This is a very useful feature in sites that have “totemic works of art” near which every visitor wants to stand for a long time, often inconveniencing other visitors access (i.e. the Lions Gate in Mycenae).

Finally, Agamemnon can contribute to the preservation of the sites thanks to a very simple but effective idea. The utilization of the Agamemnon system, in fact, generates a relevant quantity of digital pictures that represent a free stream of information in real time on the status of the photographed monuments: it will be possible to record in a special database all these pictures, that remain at guardians disposal for monitoring the site.

3.2 Personalization of Cultural Contents

A key component of the Agamemnon system is the capability of profiling the visitors before the visit starts. Agamemnon will offer a web site where people can log in (directly from home or at the site entrance) and provide their preferences for preparing their own visit. The data requested are: language, age band (12-18/adults), time available (one hour/two hours/all the necessary time), the degree of knowledge and interest in the archaeological domain. Obviously the “human capital” will be determined with indirect questions, such as how often user frequents archaeological sites/museums, for avoid make the visitor feel uneasy asking him information about the scholar degree or the cultural level of knowledge.

Another essential parameter in order to profile the visitor is the available time, because the amount of time that each visitor wants to dedicate to the visit is an individual element, in relation both to the use of the visit and the level of knowledge and information on the history of the site. Together with the age band, this is the most relevant criteria in personalizing the messages and their contents: it allows to differentiate the length and the typology of the messages proposed (audio clip are most appropriate when the budget time is not high because they request a minimum comprehension effort), or suggest to offer the “crowd avoidance” messages.

Therefore three visitor profiles will be build (we call this “static profile”): kids to 12 from 18 years old; adults with basic interest level; adults with high interest level. The purpose of this categorization is to provide each category with the most appropriate messages, by the point of view of the lexicon, the contents, etc. Moreover, during the visit, Agamemnon will be able to “observe” how a visitor is behaving and let such “static profile” evolve in order to reflect a visitor’s present interests (we call this part “dynamic profile”).

As far as the “12-18” age band is concerned, the visitors who belong to this group are presumably students of the secondary school and have a certain capability with the technologies applied to the 3G mobile phones. For this reason, Agamemnon can have a great success with this kind of public and can show considerable potential as regards the educational methodologies and needs. Therefore, it will give attention to the construction of the messages addressed to this age group, offering a really tailored product, very useful for the teachers taking their classes to visit the site. The language used will be unspecific and easily understandable and will excite curiosity and interest, stressing not the information strictly related to history and archaeology, that could be “cold” and boring for them, but what concerns the civilization and the sociological aspects (for example everyday life of the ancient inhabitants), giving preference, if possible, to curious and captivating details. It will also stress the teenagers attention to differences between the ancient way of life and the present, preferring a narrative kind of language, that rouses the imagination and the curiosity (for example remembering legends and mythical tales by means also of brief quotations). The messages devoted to a non specialist adult public will replace the technical words to others more understandable, explain the mythological and historical references, for example in the nouns of the monuments, and offer general and wide-ranging information, directed to illustrate the most important

historical background.

On the contrary, when we address a public that has more familiarity and knowledge about archaeology and history, both in general and about the specific site involved, we will use the appropriate technical lexicon, pointing the visitor attention on specific elements such as the datation problems, the archaeological excavations and finds, the architectural/artistic features, the in-depth quotations of literature, etc.

The multimedia capabilities offered by 3G cellular phones are exploited in order to make the descriptions richer, easier to grasp and, in the overall, more enjoyable: not only can the users be provided with text descriptions and images (maps, tridimensional reconstructions, aerial pictures and much more), but video and audio clips are given, where appropriate.

When the visitor will have received the essential information about the monument, he will have the possibility of asking for other more in-depth contents, offered by means of a list of topics that will be differentiated according to the visitor profiles.

These additional contents should be showed to the visitor grouped into general categories, as the following:

- Everyday life: family, house, transport, communication systems, technologies, consumption of energy, dietary habits, history of costume, political life, religion, business activities, etc.
- Archaeology: history of the excavations, finds description, reconstructions, hypothesis and interpretations, etc.
- History: wide-ranging information in order to set the site in its historical context, comments on what is happened before/after the construction of the monument or the foundation of the site, etc.
- Mythology: characters, legends, curious anecdotes linked with the site/monument, etc.
- Religion: deities, burial rites, creeds on the afterlife, etc.
- Literature: famous passages of the ancient or modern literature that talk about or have quotations related to the monument and /or the site, bibliography to increase the knowledge of the monument or of the site, etc.
- Architecture: building technologies, technical details, explanations on the technical vocabulary, etc.
- Art: descriptions of the subjects, painting and sculpture technologies, decorative arts, etc.
- Museums: information on the museums which contain the finds coming from the site, suggestion about other interesting local museums, etc.

3.3 The Typical Agamemnon Visit Path

The main steps that constitute a typical visit guided by the Agamemnon system are :

1. check if the visitor has already supplied profiling information, and in affirmative case :
 - a) drive him to the first scheduled place by providing indications on how to reach it (an image or a map, written instructions...)
 - b) recognize another object he desires to see: this can be done by taking a picture of a monument (or by selecting it on a provided menu, if the system need help in the recognition process)
2. provide the visitor with multimedia data on the object selected (the first proposed monument or another recognized object), on the basis of the visitor's profile (the visitor may also ask for supplementary data)
3. in every moment of the visit, if the visitor is interested into specific details (e.g., the capital of a column), he can take a picture of it and send it to the imaging subsystem for

recognition and to obtain additional information

4. check what are the further monuments to visit and suggest the next one.

The visitor is never forced to follow the suggested path, but with the help of the recognition system, he is completely free of auto-schedule his visit asking in every moment for cultural information about the specific object he wants to know in detail. The System Menus offered by the system are context-aware, that means that according to the various moments of the visit, only those actions that really have a sense in that moment will be made available. In general menus will behave like "pop-ups" of the MS Windows applications.

Agamemnon provides 11 menus and relative screen pages. The homepage screen welcomes the visitor and asks him if he will start with the suggested visit ("Next monument"), or go directly to a monument he prefers ("go to") or take a picture of a monument he would likes to be informed about. Other screenshots are the PATH – LIST providing the list of available monuments, the PATH - MAP displaying the site map, and the MONUMENT OVERVIEW providing a short description of the monument proposed for the next visit together with some indications on how to reach it. Clicking on button "VISIT" the user will drive Agamemnon to start the visit from the highlighted monument, while clicking on "SKIP" he will address Agamemnon to redirect the visit to the next monument on the visit path. The MONUMENT IDENTIFICATION BY PICTURE screenshots provide a visitor with the capability of taking a picture of a monument, or a detail of it, that will be recognized and identified by Agamemnon. Other screenshots are the TOPICS: a set of multimedia information (descriptions, pictures, movies, speech) pertinent to a specific monument; the information displayed depends on the specific visitor's profile, so the same basic information could be presented in different ways to different users.

3.4 Attention Awareness and Imaging Engine

In the framework of 3G and 4G phone-based mobile applications, context and location-aware information retrieval represent a strategic feature. Agamemnon determines visitor's attention just by recognizing one or more pictures taken with the digital camera embedded on most of the latest cell phone. By recognizing what the user is aiming at, the system can infer information both about its geographical context and its cultural interests, and react by sending back to the user a tailor made multimedia content. This approach does not require high-tech gadgets like compass, GPS or equivalent. Since third generation mobile networks are already a reality, in the near future we expect that every tourist could benefit from this kind of service.

Agamemnon uses the imaging engine for obtaining location and context awareness information. In other words, the key idea inspiring Agamemnon is to use context-awareness to enhance the quality of a visit by giving to the user the capability of making queries about an object simply by photographing it. This requires the capability of relating the present user location and his present interest in a specific object at the site to the virtual environment. The second key idea is the personalization of the tour, using user-supplied information, the dynamic context, and dynamic updating of personal interest for updating the planned visit in real-time.

The main purpose of the imaging engine is to analyze images coming from the cellular phone and recognize the object (or the place) that is depicted.

There are some limitations to be respected: the image should contain only one foreground object and the image should be neither overexposed nor underexposed or strongly shaded. The imaging system will return an ID code of the recognized object,

or an error code and the user can query information about recognition confidence.

The imaging system is based on multi-feature description and statistical pattern recognition. The feature-based approach mimics the biological vision system that, rather than considering the whole image, tends to identify and use basic structures and features.

Therefore, each image is described by a suitable set of low-level and high-level features, each of which quantifies a single property of the input image. Given that the feature-based description has to be both smaller (in order to save space for storing and reduce processing time) than the original image and still carry enough information, it is very important to choose a suitable feature set.

A first prototype of the image-based context awareness engine has been realized. We collected a number of images from the archeological sites of Paestum and Mycenae. Each target object has been photographed from several different view points and distances. From the two sites four target objects have been chosen, and both a training and a test set has been collected by random selection from the complete image set.

For the prototype implementation, we plan to use a small set of features and each feature-based image description is a vector of real values, of fixed length. The vector length represents the dimension of the specific feature space. In the testing and real-time operation phase, each incoming image is pre-processed using all available features, thus providing different representations. Each representation is matched in its feature space using the previously trained Support Vector Machine.

Each SVM will output a recognition result that is one among the class the SVM has been trained with. The final recognition is obtained by comparing all the feature-generated SVM results: if a certain percentage of SVM (for instance more than 50%) agree on a particular class, than that class will be the official output. Otherwise a warning message is raised and the list of output is output to the main system, for proper management. A preliminary test performed with a small training (115 images) and test (113 images) set has produced good results (80-90% of success).

4. THE SYSTEM ARCHITECTURE

Agamemnon is an application running on visitors' own 3G mobile phones. Even considering the computational power of which new models are capable of, it is impossible to implement all the innovative functionalities planned in Agamemnon on today's 3G mobile application. For this reason, the "computational-intensive" components of the system will be executed on one (or more) fixed server machine ("the Agamemnon Server"). Agamemnon will connect to these server machine via the UMTS network.

Regarding functionalities for site security aspects Agamemnon server will be accessible through the Internet for security personnel, by means of a dedicated interface.

Moreover, in order to optimize the time of a visit, some functionalities, like the introduction of user profiles, will be made available to visitors via the Internet, in order to fulfill/supply profiling information from home before starting the visit. In order to summarise how the various components are allocated on the system hardware, we can stress the following point:

- The mobile phone implements the *Visitor Device Interface (VDI)* dispatching to the user all information made available by the server. The VDI implements the menus navigation system and performs all the communications with the server-side components.

- The Agamemnon server implements: the server-side part of the Visitor Device Interface, the Visit Optimizer, the Visitor Profiler, the Cultural Mediation System, the Preservation Monitoring system, and the Imaging subsystem. It should be noted that, in order to improve the overall system performances due to the intensive computational requirement of the imaging subsystem, it could be necessary to install it on a second server machine.

The database server system implements all multi-media information relative to the site. Other system modules may need to store information in a system database (i.e. user profiles).

5. THE PRESERVATION SYSTEM

Agamemnon aims at contributing to the preservation of cultural heritage thanks to the *Preservation Monitoring Module*: it uses the images collected through the interactions with the visitors, to offer site managers a set of tools for monitoring, at a low cost, the status of conservation of the site. This system will allow an automated and constant monitoring activity on the whole archaeological area without requiring the intervention of specialized and dedicated personnel, and producing a more timely reaction in case of significant changes in the monument's preservation status. Erosion and natural deterioration of artifacts and intentional damages can be monitored with efficacy.

In this area, the main targets of Agamemnon are:

- To maintain a comprehensive repository of photographs acquired during normal system usage, without requiring any special user involvement or extra equipment.
- To automatically classify the photographs by using the Imaging Subsystem's capability to recognize a monument or artifact depicted in each photograph.
- To support personnel in annotating photographs with specific comments or notes about the object current state and mark photographs as "suspected" of presenting signs of deterioration.
- To display the collected photographs in user friendly and intuitive way, allowing easy investigation of the monuments (for example, viewing photographs of a specific monument for a user-defined interval of time, to inspect the monument's state as over time).

At un@guarded sites Agamemnon could be the only means of preserving monuments, providing a cheap and convenient way of remote monitoring the site: in fact it is sufficient to have someone of the organization responsible for analyzing the alarms sent by the Agamemnon security subsystem. This situation is well reflected by the actual condition of the two pilot sites (Paestum, Mycenae) where a security system is not present (except on-site guardians), and where previous attempts to install fixed cameras failed due to various technical and economical reasons (vandalism, maintenance costs).

Finally, the fact itself of using a device against wasting is a kind of "psychological" barrier which helps in any case to reduce the number of intentional damages. The Preservation Monitoring module will be used by site personnel, based on fixed workstations within sites premises. For this reason, it does not have the graphical constraints of the small devices used by visitors. This module will take full advantage of traditional web browser, directly connected with the rest of the Agamemnon application. The "mock-up for Sites Security" simulates the main functionalities that will be provided by a set of screenshots. These functionalities are:

1. Show images collected in chronological order
2. Show images collected auto-categorized by monument
3. Warnings section

Thanks to the Imagine System, Agamemnon will be able to

understand which monument each picture is taken from. In this way, it will be possible to perform an auto-categorization of the security images, and site personnel will be able to have an instant snapshot of the situation of each monument in the site.

6. CONCLUSIONS

As we have try to show, mobile camera phones support a novel approach to guided visits that can improve cultural heritage understanding. This is due to an extremely personalized visit mechanism based on the *in situ* capability of gathering information in real-time by simply taking a photo of a monument in which he is interested at that time. This approach gives the visitor an extremely active role in driving his own visit and in expressing his specific cultural interests about encountered monuments and finds. Digital image recognition and camera phones together introduce a new kind of imaging application that can be extended to other fields, such as visits of towns, long paths with picture annotation, monument preservation and so on.

Agamemnon will attract more people to visit archaeological sites through the use of advanced IT: not only young people, typically more computer literate, but also the elders, thanks to the use of very user friendly devices such as 3G mobile phones. All this will, therefore, have an enormous social impact by not only contributing to increase the number of people accessing archaeological sites, but also by enabling them to have a real cultural benefit from such access. This precious support will be provided at very little additional cost than the cost of the entrance ticket, for example the cost of few minutes of mobile telephone call (3' on average per visit) thus providing a benefit even to those people which cannot afford the costs for an experienced tourist guide.

Agamemnon, which leverages on the capillary penetration of 3G cellular networks and terminals, overcomes the limitations of previous solutions because there are no need for massive capital investments (as the network is there, and virtually every tourist owns a handset), that makes the application accessible even to the smaller sites, and affordable for the medium-large ones. In a business perspective, the most important opportunity is the incredible potential for developing a profitable service business in partnership with network operators, exploiting models already offered on the market (sports, news, etc.); at this purpose, future extensions of the Agamemnon system to the visit of larger archaeological areas are planned. A testing in Pompei is yet scheduled, while the application to large historical centers of ancient towns, like Venice and Florence requires consistent extensions for location sensors management, and for integrating map guided navigation and geo-based searches.

REFERENCES

- Richards, G., 2000. Cultural Tourism. In: McManus P. M., Archaeological displays and the public. Museology and interpretations, London.
- Rieu, A. M., 1988. Les visiteurs et leurs musées. Le cas des musées de Mulhouse, Paris.
- Solima, L., 2000. Il Pubblico dei Musei, Rom