THE SMARTCITY PROJECT: INNOVATIVE TECHNOLOGIES FOR CUSTOMIZED AND DYNAMIC MULTIMEDIA CONTENT PRODUCTION FOR PROFESSIONAL TOURISM APPLICATIONS

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Abstract - This paper presents the first results of the SMARTCITY project, co-funded by the Tuscany Region under the POR CREO 1.d program. The project proposes an innovative methodology as well as advanced technologies enabling professional services for cultural tourism applications in urban areas as well as larger archaeological sites.

As of today, many scientific and technological efforts in this sector focused on the introduction of technology and on all the advantages it brings in cultural and tourism scenarios, rather than content. In addition, the lack of a thorough analysis of the needs and behavioural pattern of the new "experience tourists" performing real or virtual tourist routes, strongly limits the impact that new technologies have on the development of innovative products and services capable of completely fulfil user expectations.

INTRODUCTION

SMARTCITY aims to introduce important know-how and product innovation, in order to acquire a higher level of competitiveness, and enter promising business sectors in the field of interactive media and digital services for urban cultural tourism.

The project is carrying out a research aimed at analyzing the behavioural patterns as well as information use in "experience tourism" and the creation of integrated systems for the design, production and delivery of dynamic multimedia content for the customized fruition of real or virtual tourist routes.

The project developed a collaborative platform where non technical user from tour guide publishers can easily design and develop multimedia content for the proactive and personalized fruition of tourist routes and cultural paths both in physical locations (e.g. in the context of art cities) and in virtual. The dynamic content generated can be used by the next-generation audio guides as well as for off-line and on-line interactive visit supports. The project will enable the development of software applications to improve productivity and efficiency in reuse of the content resources made available through mobile devices (satellite digital audio guides and 3G handhelds) or usable in contexts of virtual tours, supported by realistic 2.5-D and 3D reconstructions.

The aim of the project is to develop methodologies and solutions to meet the emerging demand of fruition of the cultural space and cognitive mediation directly or implicitly expressed by tourists. To this end, the project tries to replace old manual techniques and "handcraft" manufacturing solutions, characterized by high intellectual labor intensity and very low flexibility in reuse and adaptation of the content, with industrial oriented methodologies suitable for large scale production, aimed at different fruition target, flexible in reuse and content cross-referencing. Such innovative methodologies allow to realistically enforce the business assumption of systematic, efficient and flexible market coverage of the national landscape of cities and places of culture, starting from the Tuscany regional scenario.

In the context of the SMARTCITY project, the research activities build the basis for the prototyping of innovative solutions for: (i) the production and delivery of interactive content for

the emerging tourist audio guide systems integrating GPS positioning technology, digital audio/video, urban connectivity (Wi-Fi, WiMax) and magnetic sensors for orientation, and (ii) the presentation of audio guide's georeferenced multimedia content in 2.5-D and 3D scenarios, both off-line and on-line, which can be experienced in "natural" mood through real-time rendering solutions. Both areas of work, synergistic, aim to define new ways of technological and content oriented *cognitive mediation* of the cultural and tourist experience, by implementing in a simplified but pragmatic and effective way, the paradigm of *ambient intelligence*.

The remainder of this paper is organized as follows. The next section, Section 2, surveys the related work and describes our general approach. Section 3 describes the modeling of user experience in tourism fruition. Section 4 presents the knowledge extraction techniques developed. Finally, Section 5 concludes the paper.

GENERAL APPROACH AND METHODOLOGY

Currently there are no sufficiently complete studies and analysis related to the needs and behavioral patterns, according to an *ambient intelligence* paradigm, of the new types of tourist during the fruition of touristic routes, both real and virtual. In addition, the state-of-the-art of new services is characterized by a strong focus on technology and the possibilities that it offers, while little attention is still paid to the content. This poses serious limitations in understanding how the opportunities offered by new technologies can be fully deployed to produce content and services that can meet the real expectations of users.

A further consequence of this lack of attention to the user needs and the potential impact in the field of *content engineering* is the limited productivity of the obsolete techniques used today. Despite the instrumentation used, which can be even advanced, today's tourist content engineering is characterized by a *handcraft* approach, with processes designed specifically for each location or customer, and without using methods and systems enabling an optimized production and a subsequent systematic management of the digital content *repository* with an *industrial* approach.

The main idea behind the SMARTCITY project arises from considering that cultural tourism, particularly those aimed at Italian and European cities, is undergoing a radical transformation, especially in the wake of global social phenomena, like: (i) Democratization of travel and cultural consumption (though superficial), (ii) Low-cost flights, (iii) Single currency in Euro countries, (iv) Unstructured and personal tourism experience often with strong individual focus, (v) Strong reference to personal assistance and guidance instruments, both in terms of location (GPS navigation) and in terms of cognitive orientation (individual tour guides).

In addition, a growing interest exists for less obvious and minor touristic targets, constituting the *long tail* [1] of the tourism and culture markets (e.g. the more than one hundred minor cities characterizing the Italian landscape beyond the obvious destinations such as Florence, Rome, Naples, and Venice).

In this scenario, and in a global landscape where communication and networking equipment (smartphones, PDAs, navigators, tablets) are becoming widely available commodities, it emerges clearly the problem of finding and adapting content to be conveyed to the users / urban explorers.

Hence, the problem of the lacking of tourism content is a typical paradox of generation and technology gap: having textual and multimedia materials that illustrate a specific urban itinerary today requires a non-trivial investment throughout the entire cycle of content provisioning (cultural-historical research, writing, adapting to the rhythms and timing of the visit, geo-

referencing, translation, voice, sound, compression, etc.). Furthermore, the authors of tourist guides still need to redo or revise the entire material in case of changes in the thematic finalization of the work, which is typically bound one-to-one to a specific route.

However, in the tradition of historical and art-historical studies, and in tourism literature or local narrative, there are many existing texts reflected in the local background for each city, often of considerable value and full appeal, many of which have wider rights or are reusable according to open models such as Creative Commons.

These sources are those currently referred by the authors of the texts to be produced in order to feed the touristic audio guides, to build new illustrative narratives, in a labor-intensive artisan process that often does nothing but impoverish an already existing asset. The idea is therefore to valorize and functionalize the sources of the narrative knowledge illustrating the local cultural and tourism resources, developing solutions allowing to acquire existing content into digital format, fragmenting the materials in *atoms* of properly indexed knowledge (corresponding to the *loci* of interest met during a visit), and then enable sophisticated features like thematic, structural and geographical search, narrative aggregation, personalization and customization according to the needs and preferences of users, cross-referencing between different locations (e.g. the "fountains" route, developing among different cities of the same region), with the ability to dynamically create, from the same flexible knowledge base, endless itineraries in turn adapted to the needs of the specific context.

This goal requires an effective interaction of several technologies, some mature, others more innovative, in an original synthesis with a potentially significant socio-economic and market impact, in Tuscany as well as in the rest of Europe.

EXPERIENCE: AMBIENT INTELLIGENCE IN CULTURAL TOURISM

The project started with an analysis phase focused on user experience and behavioral patterns for tourism fruition, trying to devise use cases and modelling interactions between users and explanatory/additional content as well as interactions between users and portable information devices used to access the content, and to complete and enhance the tourist experience. This phase involved the investigation of three factors of knowledge critical to define the scope and requirements of cultural tourism ambient intelligence.

We started by examining users behavior during fruition of tourist and cultural places, in order to model the behavior of different categories of users in the cultural spaces, both indoor (museums and other cultural containers) and, especially, open-air (cities, art and cultural districts).

The survey was conducted in the three test sites selected, i.e. Museo di Scienze Planetarie (Museum of Planetary Sciences) in Prato (Italy), as an example of indoor space, the city of Florence (Italy), as an example of open-air fruition context) and the monumental complex of Santa Croce in Florence, as an intermediate case between the previous two.

The preliminary work was based on examination and study of the literature on *visitor studies*, to identify any behavioral patterns of use in cultural places. This analysis also has been instrumental in defining the survey methodology. Therefore, we compared the results of the survey conducted with the results of visitor studies available in literature, in order to model the behavior of visitors in cultural places.

Next, we analysed the digital content to be delivered through mobile devices and the relationships established between such cultural content and mobile device users during the cultural experience in both museums and city environments.

The survey, conducted in the three test sites, was carried out using multiple choice questionnaires, interviews, and field studies. The comparison of results obtained with the field studies made it possible to draw a clear enough picture of the dynamics of interaction between the user and the content flow to the cultural contexts examined.

During the research, we analyzed in particular expectations, fruition logic, and user satisfaction during digital content fruition by mobile devices as support to a cultural visit. We also took into account the dynamics developed by fruition processes where the tour guides drive additional content (interactive insights, information, logistics and business, etc.). On the basis of the results obtained, we identified a possible model for the relationship between users and illustrative/additional content by analyzing, in particular, audio materials provided by tour guides in different fruition contexts and experimental objective (inference of narration / behaviors of the users) and subjective (with the support of pilot users) evidence. The model developed represents the visitor using a digital guidance during the visit of a museum (or a town, or a show), as a person with specific information needs associating a cognitive dimension to the purely aesthetic experience of visiting.

Currently the challenge in the evolution of the relationship among tourists, cultural communication and new technologies is to ensure an even easier access to content that must be enriched both in quality and in quantity, in order to meet the size and value the intimate and personal dimension of the acquisition of knowledge.

INFORMATION RETRIEVAL AND KNOWLEDGE EXTRACTION

The second phase of the project was focused on information retrieval and aimed to develop the methodological and technical foundations for a new approach to content management systems for supplying *tour guides* and focused on two aspects: (i) descriptive, topological and semantic *thorough indexing* methods for content resources, and (ii) interactions between audio and physical space, and between audio and Virtual Reality Spaces. *Thorough indexing* techniques, namely the definition and production of analytical metadata, both descriptive and semantic, associated not only to the work (text, digitized volume, etc.) in its generality, but also to its digital resources, which typically contains more "atomic" units (at the level of single-page, paper, or content section).

The indexing problem is addressed by an interesting evolution of METS (Metadata Encoding and Transmission Standard) [2], aimed at formalizing, open and dynamic, descriptive metadata can provide a complete document management of digital resources: the standard MAG (Administrative Metadata Management) [3], an XML schema that allows the definition of metadata for bibliographic unit, to its logical structure, the digital images analytical components, and the transcription of OCR pages. MAG formalizes the key components and processes supporting archiving, management and preservation of digital documents. It refers to the Open Archive Information System (OAIS) model, including the Dublin Core metadata set. Our aim was to enhance MAG format in order to implement semantic geocoding extensions.

The current technologies for information retrieval, as well as those for the extraction of knowledge, use computational tools of large capacity, but their potential it is still not fully expressed [4]. There is a gap between the knowledge contained and recovered, which in fact

prevents a further evolution step in the algorithms, in term of results and performance. The problem is that the knowledge, intended as terminology, concepts and semantic relationships between entities is not explicitly expressed, then not exploited by procedures for processing information. Many studies, designs, prototypes are trying to remedy this problem. The approach we have developed is a text enrichment technique "generalized", by means of which it can explain all forms of knowledge identified in the text, through various statistical and linguistic analysis technologies available, without using assumptions, structures and *ontologies* predefined. All information extracted, are associated at the text in a para-textual formalism, "enrich the text" of all known lexical, semantic, factual, named entities, terminologies. This wealth becomes a source of information exploitable by search engines and by classification and summarization systems available. The *TextPower* [5] technology, developed by Computational Linguistics Institute "Antonio Zampolli" (ILC) of CNR, derives from the concept of enrichment and enhancement of the text.

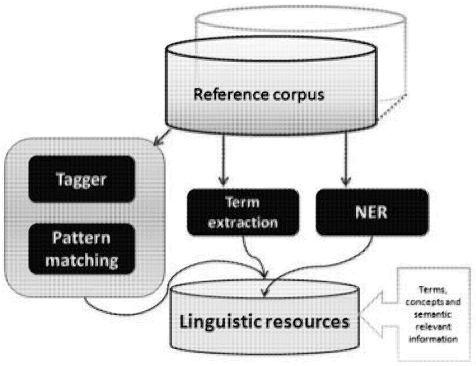

Figure 1: Schema for the creation process for linguistic resources

Within the framework of the project, our approach is to create a specific domain reference (text) corpus that contains a network of knowledge, automatically extracted, concerning the city of Empoli and neighborhoods, which offers authors semantic syntheses, useful for finding those information sources that correspond better to own needs. We divided the creation of reference corpus in two phases for specific requirements tied to the specific case study choice. The first phase aims at the extraction of documents provided by human experts, for the creation of a repository of documents. Relevant information and semantic concepts are then extracted from this first corpus. All these semantically relevant elements (such as proper names, names of institutions, names of places, and other relevant terms) have been used as basis for further acquisitions of documents from heterogeneous sources, by using specialized crawlers that work on a bulk of text materials available on-line. Thus it has been possible to use the extracted knowledge as basis for a new search strategy of text materials.

All textual materials acquired, were indexed with *DBT*[1] procedures. By using a specific tool, developed by ILC, named *PiTagger*[2], we then applied a tagging phase, so to identify all lemmas and relative POS in each document. The *PiTagger* associates each word to the related lemma by using the morphological component of the Italian language, in this case *PiMorfo*[3]. The

[1] DBT (Data Base Testuale, *Textual Data Base*) is specific module for the treatment and analysis of textual and lexical material.

[2] PiTagger is an important component for text lemmatization and tagging and constitutes a software module of PiSystem: integrated system for processing of textual and lexical materials.

[3] PiMorfo: system for morphological analysis of the italian language.

ambiguities are solved by following a statistical approach on the basis of a training corpus statistically analyzed and summarized. Multi-word were extracted from reference corpus, by exploiting pattern matching techniques. Typically, in the Italian syntactic construction "N-preposition-N" and "ADj-N/N-ADj" are the most productive linguistic patterns. Statistical algorithms analyze the distributions frequency of each pattern identified. On the basis of results we extracted a set of semantically relevant terms and concepts for cultural heritage domain in Empoli and neighborhoods, as shown in Figure 1 above.

CONCLUSIONS AND FUTURE WORK

The project SMARTCITY is addressing advanced tourist audioguide editing processes taking advantage of industrial practice, research progress and emerging web 2.0 technologies, which will provide a basis for its commercialisation and sustainability. The involvement of real users, i.e. professional tourist guide editors, in the development of the methodology and tools is essential for its acceptance in the target markets.

The first part of the reseach was dedicated to accurately and concretely modeling of user needs and behavior during fruition of cultural tourism events, and to the analysis and development of an innovative methodology for information retrieval and indexing of a large unstructured knowledge base.

Next steps in the project are to finalize a system architecture integrating the different system components (knowledge extraction, indexing, authoring editor for guides) and to design and implement the authoring tool for preparing multimedia tourist guides. Finally, the authoring tool will be evaluated with real professional tourist guide authors.

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References

[1] C. A. Iglesias, M. Sanchez and F. Spadoni, "VARIAZIONI: Collaborative Authoring of Localized Cultural Heritage Contents over the Next Generation of Mashup Web Services", *3rd International Conference on Automated Production of Cross Media Content for Multichannel Distribution*, AXMEDIS2007, November 2007

[2] METS, http://www.loc.gov/standards/mets/

[3] MAG, http://www.iccu.sbn.it/schemag_2.0.htm

[4] E. Sassolini, A. Cinini, "Cultural Heritage: knowledge extraction from web documents", in LREC 2010: Seventh International Conference on Language Resources and Evaluation, Valletta, Malta, 17th – 23th May 2010, Procedings, Nicoletta Calzolari (Conference Chair), Khalid Choukri, Bente Maegaard, Joseph Mariani, Jan Odjik, Stelios Piperidis, Daniel Tapias (eds.). European Language Resources Association (ELRA), Paris, France, 2010, isbn 2-9517408-6-7

[5] E. Picchi, E. Sassolini. "Text Power": tools for the Cultural Heritage, in 4th International Congress on "Science and Technology for the Safeguard of Cultural Heritage in the Mediterranean Basin", Cairo, Egypt, 6th – 8th December 2009, Procedings, pp. 277 – 278, A. Ferrari, E. Sirugo, s. Tardiola of insitute IMC (CNR) Rome, Italy, 2009