Manual of Wise Management, Preservation, Reuse and Economic Valorisation Of Architecture of the Totalitarian Regimes of the XXth Century

Supporting Cultural Route Sustainability via innovative digital heritage applications and services

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ABSTRACT

The visibility, recognition and impact of a cultural route can be significantly enhanced with the support of dedicated ICT tools and associated technologies. A synergy of multi-faceted information representation and cataloguing with electronic guidance applications can enhance raise the potential impact of a cultural route by making it virtually accessible to very large internetworked communities of users. A virtual cultural route can offer a prospective visitor access to content which is either directly relevant to the route, a visual perception of the route and associate heritage concepts and objects, the opportunity to consider and plan a visit in an area of potential interest, as well as to link up to a community of other users. Furthermore, relevant stakeholders may have a tighter integration with the route, linking up their business and offered services to potential visitors, customers or other businesses, educational, scholar and governmental organizations that may bear relevance to the route. Ultimately, the virtual cultural route can support the establishment of a network of interlinked communities, with common cultural, educational as well as financial interests. This article offers an overview of how ICT technologies can contribute to the valorization of a cultural route, while offering practical implementation insight.

Key-Words: cultural route, digital applications, mobile guides

1 DIGITAL HERITAGE

Traditional means for cultural heritage valorization can be considered to have relatively limited impact, while incurring relatively high costs. Printed material in the form of pamphlets, posters, booklets and maps offer visual promotional means addressing a vicinity of interested parties. Instead, a virtual cultural route can be supported by a range of computing and communication technologies, offering access to content and services to large communities at low costs with potentially wide-reaching impact. The introduction of innovative ICT technologies in culture and tourism has rapidly redefined the way the valorisation of cultural and in particular architectural heritage is pursued. The new technologies can provide and present content in novel ways. Such content can have a multi-facet form, edited by a wider community of experts and non-experts, while being interlinked with digitally represented spatio-temporal information, offering a cohesive vision of digital cultural heritage.

Architectural heritage, in particular, can take advantage of a number of now widely available enabling technologies to further propel scholar but also educational, as well as tourism-related activities, upgrading the valorization potential of cultural assets. Furthermore, such benefits can be brought via cost-efficient means, as scaling to large user groups at affordable costs is much easier with the aid of ICT technologies.

2 WEB-BASED AND MOBILE COMPUTING

ICT-enabled cultural route systems can support on-site visitors or remote virtual visitors. Such systems are typically designed to follow a three-tier architecture, as depicted in Figure 1, with the localization element typically present in mobile applications. Each tier exposes a clean and as-simple-as-possible interface to the other connecting tiers and encapsulates all implementation complexity.

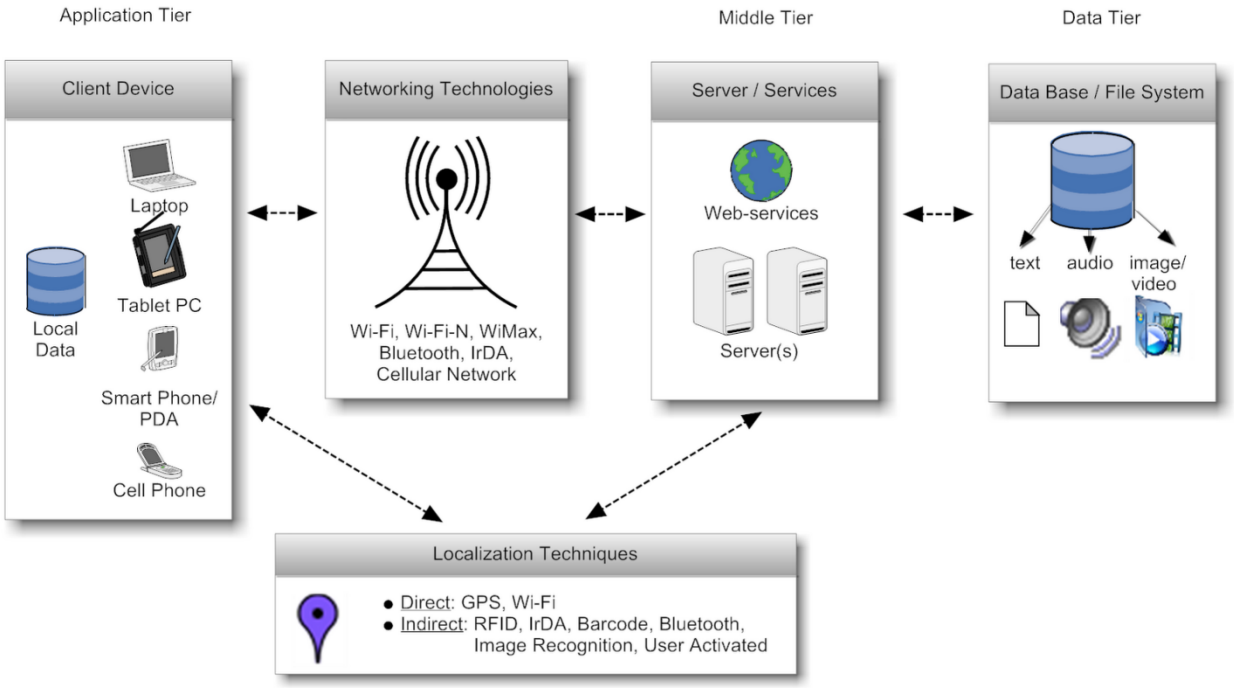

Figure 1: Typical tree-tier architecture for cultural heritage mobile and desktop applications

The data tier refers to the physical data storage and structure. In most cases, it resides in a remote server; however, it is also possible to be distributed across multiple servers or stored locally, at the client device. The middle tier offers middleware services and implements a part of the application logic required, mostly related to the management and delivery of the data tier content. The middle tier also typically resides at the server-side, unless content data are stored locally. The application-end tier of a digital heritage application, the third tier, typically comprises the software on the client device.

Cultural route support systems may deliver content to multiple client device types, including mobile and desktop devices. The networking component interfaces the client and middleware tiers, ensuring content delivery. It can also be employed for data access by the middleware, when content resides at a location different from the middleware server, or when data resources are of distributed nature. The localization component is in most cases present at the client side, but has access and is linked to the middle tier, for services adaptation or data retrieval. It is the basis upon which to offer location-based services (LBS).

The innovative ICT technologies which have been introduced in culture and tourism are comprised of a multitude of enabling factors, all of which contribute to breaking barriers between information segments, stakeholders and actors and the wider public. The confluence of such enabling factors consists of:

- Web-based and semantically enriched digital heritage and information interoperability
- Social computing
- Mobile and situated computing
- 3D, virtual and augmented reality technologies
- Wireless communications, including local and metropolitan area networking, as well as post 3G cellular telephony
- Multi-facet information representation, especially layered GIS (Geographic Information System) and 3D GIS technologies

3 TECHNOLOGY USAGE IN DIGITAL CULTURAL ROUTES

3.1 Web-based and semantically enriched digital heritage assets

Enabling distributed information access and availability makes digital heritage content more easily discoverable and thus exploitable by versatile web-based applications. The departure from past isolated and fragmented cultural heritage information repositories has lead to an era where data and knowledge needs to be linked in order to be perceived as truly useful. Additionally, interoperability stands out as an equally important aspect, enabled through semantic representation standards for cultural and architectural assets, such as CIDOC (Doerr 2003) and LIDO (Pitzalis et al. 2010), as well as via initiatives to establish common heritage repositories, such as the Europeana (Doerr et al. 2010) digital library. Thus, digital heritage emerges as a key technological push leading to enhanced accessibility and ultimately more efficient valorisation of the actual physical heritage assets.

3.2 Mobile and situated computing

Since the mid 90's a number of 'e' applications, such as e-commerce, e-learning, Internet-gaming, e-sensing and data acquisition, Internet cultural and tourism guides and e-health, have emerged. They have steadily grown in maturity and have redefined the ICT business and applications landscape. A more recent trend has been marked by the advent of wireless technologies and mobile devices.

The abundance of mobile devices in everyday life, either in the form of smartphones or tablet computers radically transforms the usage pattern of a digital heritage application. By empowering the user to become a mobile actor interacting with the surrounding environment, mobile devices deliver situated computing services, which can be adapted to the context of the specific use each time. Mobile guidance applications are typical enablers of a nomadic computing usage pattern, applicable both to single individual users and visitors, as well as to groups of users (Emmanouilidis et al. 2012).

Mobile applications offer benefits which cannot be matched by desktop ones. The key advantage is the combination of mobility with 24/7 multi-connectivity in order to deliver contextualized application services. Contextualization refers to the capability to offer the right information and services, tailoring them to the right device, to the right user, at the right time and location. Although context-dependent delivery can be relevant to non-mobile applications as well, the flexibility offered by the device and user mobility places mobile applications at the very heart of context-aware computing.

Furthermore, as mobile devices and tools are being increasingly employed in collaborative settings, the prospect of true mobile collaboration is raising expectations for deeper business penetration of mobile guides. Such expectations are supported by the emerging characteristics of mobile applications, including active data management, enhanced web-based interactivity, easy access to knowledge and information, and usage of advanced communication networks.

Mobile guides provide context-dependent, multimedia-rich touring services for visitors. A typical scenario is that of a user operating a portable computing device in order to get interactive indoors or outdoors aid. The aid can include location-awareness, map-based navigation, contextual information delivery and availability of adaptive and context-dependent services.

These types of applications emerge as a key enabling factor for the valorisation of cultural routes and architectural heritage, encapsulating the main functional elements of guiding a user through a cultural route, but critically, also tailoring the offered information and services to the individual user's characteristics and the context of each service request.

3.3 Virtual, augmented reality and 3D technologies

While three-dimensional modelling has been at the heart of architectural modeling of building and urban spaces in recent years, the combination of 3D representation with Virtual Reality and the possibility of user immersion within a virtual world, offers an innovative rich navigation experience, bringing the physical assets and architectural monuments closer to the prospective visitor, without an actual visit having to take place. Furthermore, the ability to annotate virtual objects with semantically enriched information and links to other digital assets makes virtual navigation a truly stimulating, educating and rewarding experience. Modern

technologies with quickly broadening support such as WebGL (Khronos WebGL Working Group 2012) enable 3D content presentation and manipulation on a large majority of modern mobile and desktop devices.

Additionally, the usage of augmented, rather than virtual reality can superimpose semantically enriched data and associated digital assets with real scenes, creating a multi-facet navigational environment, bringing closer the visitor with the visit subject and its associated background information. Mobile augmented reality-aided interfaces (MAR) are increasingly pursued in mobile guide applications (Krevelen and van Poelman 2010), offering an engaging and intuitive navigation interface that provides contextually relevant information and services to assist visitors in focusing on the real visit points of interest. MAR can be marker-based (i.e., based on visual cues or tags) and markerless, with the latter employing GPS (Global Positioning System) or other localization capabilities, together with Augmented Reality (AR) browsers to display information in a fused manner, which makes the interaction with the system much more intuitive and natural. MAR takes advantage of GPS, compass and accelerometer data to constantly sync the user position and orientation and adapt the user interface accordingly. More advanced features include image recognition utilizing the device camera, or wearable input devices that substitute on-screen mobile user interfaces.

3.4 Social computing

Social networks have had profound effects on the design of online applications by transforming their user acceptance requirements. Online applications now need to be socially-aware and this is achieved by enabling users to collaborate, share information and communicate based on existing or new social networks. Social computing allows users to maximize the utility of the applications to themselves and their social circle and to produce results faster, something of special interest in more business-oriented applications. User communities can also enhance applications by enabling features which are not possible by automatic means alone: user-contributed content such as comments and guides as well as ratings and reviews allow filtering and sorting information based on human-generated rather than computer-generated evaluations. Socially-aware applications allow communities to enter a virtuous cycle of social activities which significantly increases the value of the application to all involved stakeholders.

However, incorporating social context and features introduces additional functional and non-functional requirements to be addressed. For example, real-time communication makes networking quality of service even more important. Beyond non-functional constraints, care must be taken so that social interaction does not distract the user, but rather enhances the visit experience. Alternatively, social context can be interactively resolved by means of augmented interfaces, such as in Mobile Augmented Reality (MAR) implementations. For example, different layers of social networking entities can be superimposed on a map-based or camera-view-based interface, allowing the user to select the context of interest.

With the increasing ubiquity of social networking applications, it is also expected that users will find it natural to combine mobile guidance usage with their commonly employed social tools. Mobile guide solutions vendors will seek to exploit this trend by providing a tighter integration with social tools.

3.5 Wireless communications

Wireless communications play a vital role in the realization and efficient utilization of mobile guide applications and bring ubiquity in the delivery of digital heritage applications and services. Internet connectivity in mobile guides enables information access from external sources, for example, retrieving information on facilities and services that might not be included in the mobile guide, integrating relevant stakeholders, enhancing the utilization opportunities and the added value of the mobile application.

Network availability and conditions represent an important system context parameter regarding the service delivery to mobile guide users, largely affecting the offered quality of service (QoS). It is one of the key non-functional requirements shared across this applications domain. Applications with heavy bandwidth requirements need to take into account both the network speed available as well as prioritize traffic depending on the time-sensitivity of the information to be delivered. Additionally, data delivery may be affected by network congestion caused by the presence of several mobile guide users within a limited space. The adaptability of the offered service to the network conditions, e.g., by transmitting a lower resolution or frames-per-second video to mitigate network congestion problems, is vital to the safeguarding of satisfactory service delivery under unfavorable network conditions.

In order to achieve an always-on connection to information resources, wireless devices need to support cross-network interoperability to seamlessly migrate between networks without service interruption.

Available wireless networking protocols include Wi-Fi, WiMAX, Bluetooth and cellular networking, currently in the form of GPRS and 3G and rapidly moving towards post-3G, such as LTE. In general, Wi-Fi is the prevailing networking technology amongst mobile guide applications. Cellular networking is often utilized especially for mass mobile services in large urban spaces, due to its universal coverage, but Wi-Fi can also be employed if available. Higher bandwidth and range is likely to be achieved by usage of mobile broadband 4G protocols currently under development, namely LTE-Advanced or WiMAX IEEE802.16m, which were both proposed to meet the requirements of the IMT-Advanced (Abichar et al. 2010). Kenteris, et al. (2011) provide more specific details on the networking solutions used in mobile guide applications.

3.6 Multi-facet information representation, especially layered GIS and 3D GIS

Among the different aspects of information representation, that of spatial representation in the form of Geographic Information Systems (GIS) has gained great popularity. Not only it is a natural way of registering digital heritage information and data to specific locations, but it can also be exploited in different digital guidance and navigation applications. Furthermore, offering a layered information representation, GIS systems can offer a multi-facet presentation, delivering the right information associated with the desired representation layer. The 3D representation is a further addition to GIS technologies, bringing together map-based and 3D representations.

A further exciting valorisation prospect is the addition of the time dimension and its integration in the spatial dimension, adding the possibility of navigating through time and space in an area or cultural route of interest. This spatio-temporal view of a cultural route contributes to a deeper understanding and a more profound perception of the actual cultural route concept.

3.7 User localization

Localization can be divided into two categories, depending on the way the user's location is determined: direct and indirect (i.e., by proxy). Direct localization methods produce an absolute coordinate tuple to identify visitor location. Such methods include GPS, Wi-Fi triangulation and mobile phone network triangulation. With indirect localization, localization is inferred via "active" or "passive" elements whose position is known to the system. When the user interacts with these elements the system can infer that the user is near the element's position in the environment. IrDA, RFID, Bluetooth, bar-coding as well as image recognition can be identified as indirect localization methods.

Similar to the networking technologies, a demand arises for seamless integration of different localization technologies, both for smaller and larger area mobile guide applications. The localization task migration should be smooth during network transition. Using one localization technology can offer fast but coarser location estimation, while an additional localization technique can produce the required accuracy. For example, GPS can be used to determine the approximate location of a tourist, to provide information on nearby monuments and Wi-Fi triangulation to aid finer-grained location estimation inside or around a building.

4 DIGITAL HERITAGE APPLICATIONS AND TECHNOLOGY SYNTHESIS

The previously described technological advances can be capitalised by building applications which provide interactive and in some cases immersive experiences to both on-site and virtual visitors. Interactive digital heritage applications include digital cataloguing, spatio-temporal navigation through maps and timeline interfaces, social networking applications, as well as virtual 3D scene navigation.

4.1 Digital cataloguing

Applications which can support the better recording, preservation, promotion and understanding of related cultural heritage will significantly benefit the valorisation of both the physical and digital assets. Having instant access to up-to-date contextualized views of the data will allow experts to gain new insights into the fabric that connects cultural heritage and will enable them to augment these assets with new knowledge effectively sharing it with the wider community. For typical visitors digital cataloguing can offer a first layer of basic information about the recorded cultural assets and objectives. A digital cataloguing system is essentially delivered on top of a content management system that may support

4.2 Temporal navigation applications

The exploration of cultural heritage is impossible without factoring in time. Applications which can describe historical changes and events in terms of a visually fluid and expressive timeline can concisely and accurately convey information about cultural heritage and its evolution in time. Cultural routes can be shown as threads through time and relations between them can be highlighted. Stakeholders can integrate their own historical information and can weave a compelling story around their assets of interest.

4.3 Spatial navigation applications

Cultural routes contain a prominent geo-spatial component, which localization technologies can take advantage of to contextualize information. Map-based applications can succinctly display large numbers of points of interest and plot virtual routes over them. Users can fluidly manipulate the map to visit these locations at will or virtually follow a cultural route. This modality offers insights which can only be compared with physically travelling along the route, to gain an understanding of how space and distances have affected the evolution of cultural heritage. Furthermore, available services, navigation hints and routing suggestions can be offered by stakeholders to further aid the visitor and drive both cultural and touristic experiences.

4.4 Combined spatio-temporal systems

Combining the temporal navigation functionality with a map-based modality allows creating a spatio-temporal navigation feeling. Pinpointing points of interest and shared information across a digital map-representation can offer multiple benefits to both experts and laymen and can also integrate relevant stakeholders in the process of constructing, maintaining and expanding the cultural route, ensuring its longer term viability.

4.5 Social network augmentation

The usage of social aspects of computing can strengthen a community effect in cultural route applications and can fuel user generated content and arbitration, distributing the information update load to multiple interested users and allowing for user community moderation. Effectively turning the users into stakeholders, a community can provide higher quality services to all participants at lower cost levels and scale to larger numbers of assets and points of interest.

4.6 3D applications

With the advent of better support for 3D content virtual navigation may soon become fully 3D enabling the display of existing 3D objects and buildings as well as 3D reconstructions and simulations of objects. In tandem with temporal manipulation, whole areas and monuments can be presented along with their evolution in time, producing near-real life or even surreal experiences to virtual visitors.

5 CONCLUSIONS

ICT technologies can greatly enhance the value and impact of heritage valorisation, benefiting both cultural elements dissemination and tourism. Moreover, a cultural route concept is greatly served by a digital or even a particular mobile guidance application service. The enabling technologies are available today and they can meet quality of service requirements, while ensuring user acceptance and large scale adoption of the offered services. In this chapter, we describe the practical ways ICT can aid the development and exploitation of cultural heritage related applications, stressing the technological parameters and constraints and offering an overview of the possible applications. We comment on the characteristics of the offered user experience and its effects on the culture and tourism domains.

Cultural route support systems need to provide their functionality through fluid and attractive environmens and should allow creating, displaying and manipulating virtual routes on maps and timelines.

The cultural route application should seek to contextualize the provided service provided by modeling the user and the context of use. This should lead to a highly personalized experience for the user.

The enabling technologies and their effects in creating an efficient digital heritage mobile guidance application to support a cultural route are summarized next. Cultural route support systems should take advantage of all meaningful available technologies and follow certain guidelines to maximise the valorisation potential of the cultural route presented:

- Use semantic modelling and semantic annotations to characterise data through a digital recording tool.
- Offer the data in an interoperable format through a digital asset repository to fuel a community of data sharing.
- Allow searching and filtering datasets based on multiple dimensions (time, location, type of object, etc.) to allow focusing in specific areas and subject of interest.
- Socially-enable the application to facilitate community building and collaboration.
- Use GPS and Wi-Fi positioning as localization enabler to provide spatio-temporal contextualization to mobile and non-mobile devices.
- Enhance the presentation of cultural evolution by using timelines.
- Use 3D and augmented reality presentation methods to increase immersiveness and provide richer visualizations.
- Combine with GIS and 3D GIS systems to further enhance visual understanding (especially in combination with timelines). Maps should be sensitive to time and be able to display information contextualized with time.
- Provide data by contextualizing in the QoS dimension to efficiently service both mobile and non-mobile users.

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