Full immersion in Cultural Heritage environments: A new IDEHA for data managing and displaying

By Luca Bevilacqua, Bruno Fanini, Nicola Mariniello, Augusto Palombini, Vladimiro Scotto di Carlo, Giuseppe Scardozzi, Antonio Sorgente, Paolo Vanacore

Fig. 1 - Equirectangular projection of a scene of the viewer (case study of Santa marinella, latium, Italy), with icons targeted to different kind of media contents.

IDEHA (Innovation for Data Elaboration in Heritage Areas), is a PON project coordinated by CNR, aimed to an open platform for real-time aggregation of Cultural Heritage elements (sites, monuments, etc.) data, and their "packaging" in sets of informations for different targets of outlined public.

THE IDEHA PROJECT

The IDEHA project ("Innovations for Data Elaboration in Heritage Area", PON FSC 2018-2022 www.ideha.cnr.it), started in 2018, funded by the Italian Ministry of University and Research, under the coordination of the Italian National Research Council (CNR), and involving as partners many research institutions, as: Università degli Studi di Firenze, Università degli Studi di Modena and Reggio Emilia, Università degli Studi di Palermo, Università degli Studi di Bologna; and enterprises as: Engineering Ingegneria Informatica S.p.A.; 2038 Innovation Company S.r.l., Demetrix s.r.l., Centro di Ricerca, Sviluppo e Studi Superiori in Sardegna, Innovaway S.p.A.
The overall aim of the project was an open source real time aggregator of data from different sources (archives, social networks, digital libraries, IoT sensors, etc.), related to specific CH items (sites, monuments, objects); to group them in "packages" tailored for specific targets of public, according to their profile (tourists, scholars, technicians, etc.). The project was organized in 8 operating unities (defined as "OR")

OR1 Archiving, indexing & semantics
OR2 HBIM for CH
OR3 Open middleware for immersive & mobile apps
OR4 Smart assisted visits
OR5 Deep learning & Computer Vision
OR6 AR technologies (Visualization tool)
OR7 Business models for CH
OR8 Case studies coordination

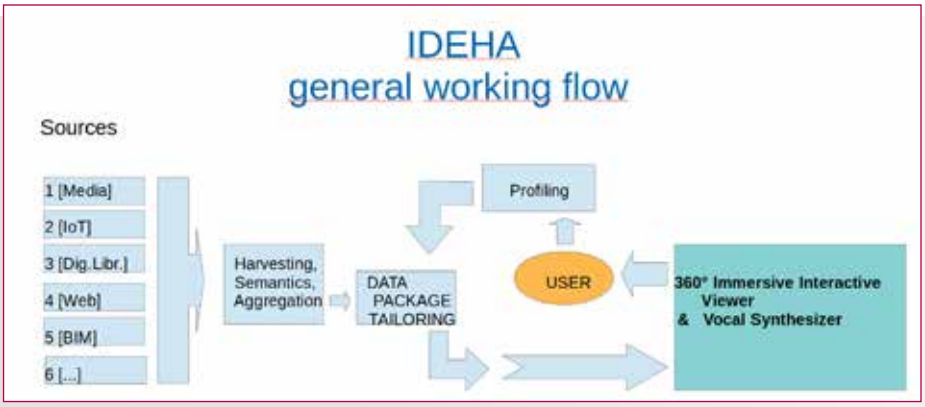

Fig. 2 - The IDEHA working pipeline (see text for details)

The present communication is Focused on the work carried on by OR6, targeted to the creation of a visualization tool, to represent the project's output, and touches as well part of the OR8 activity, in relation to the fieldwork case studies. The entire pipeline is the result of a joint work intersecting WP 3,6,8, and, starting from the general need for a data visualization, it finally evolved to become a new kind of immersive interactive viewer, useful for different kinds of data representation in many areas of Cultural Heritage dissemination and analysis.

The general IDEHA working flow concept consists in a pipeline that starts from the harvesting of different data sources, then setting up their semantic definition, and grouping them into 'packages' tailored for different categories of users, according to their profile (Fig.1).

In such a context, the data viewer was conceived as a 360° immersive interactive environment (Mazzoleni et al.2006, Skola et al. 2020), to enjoy multimedia contents of any kind, through space and time, thanks to many different narrative metaphors. The viewer is capable of playing high definition 360° videos with different categories of contents embedded, to be activated through specific icons by the user. The content type may consist in any kind of media html5 compatible, including pictures, texts, audio in the user's language through real-time translators and synthesizers, and so on; as well as the typical "virtual tour" transition icons to translate the users through different points of view (Fig. 2).

THE VIEWER DEVELOPMENT

Dealing with the data visualization tool planning, it was immediately evident the opportunity of creating a tool whose power could go over the simple project needs, and conceiving an immersive framework for different kinds of CH data. Such an aim implied a deeper reflection on the state-of-the art.

For some years now, digital technologies have become a tool of fundamental importance in the global tourism competition. Several venues are starting to offer usable digital versions of their Cultural Heritage site and collections content in Extended Reality to arouse interest and emotion. The rapid hardware and software evolution in telecommunication networks and XR-capable devices provide opportunities to gain

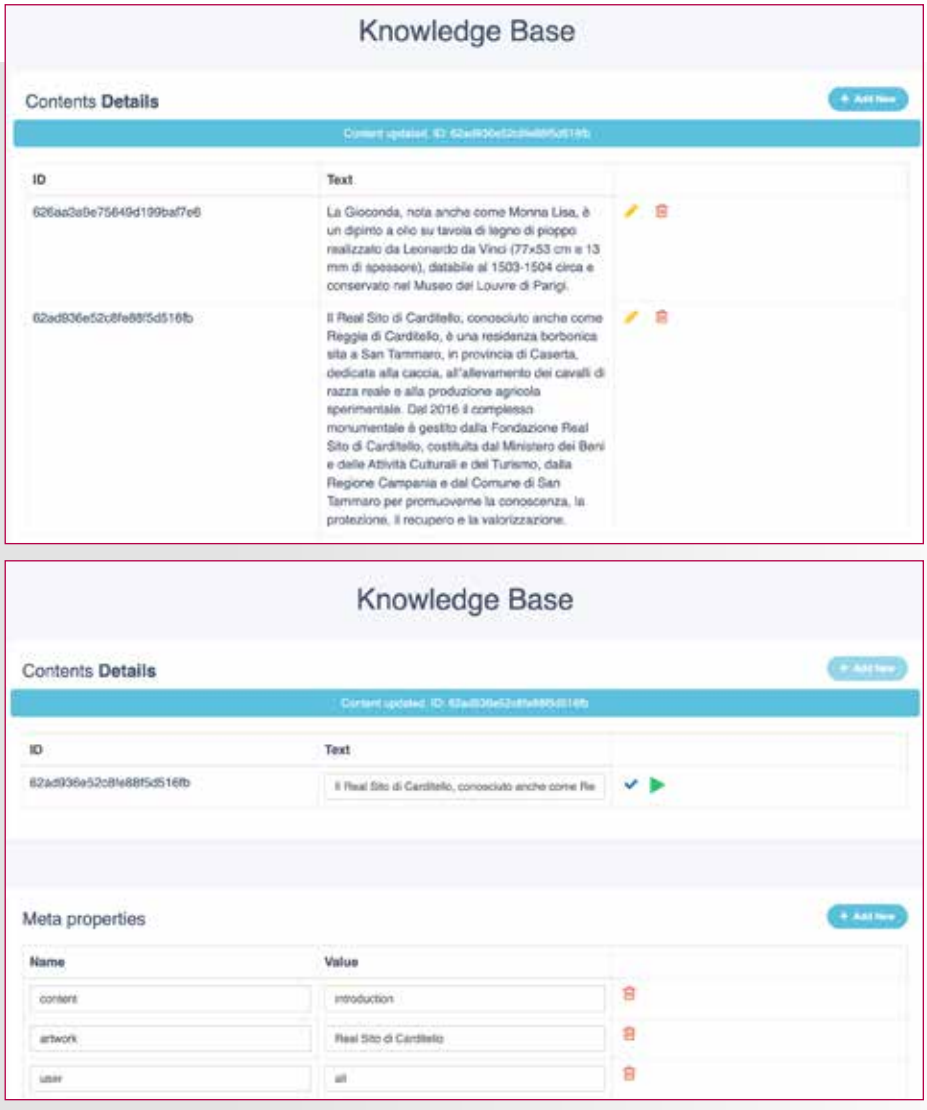

Fig. 3 - Screenshot of Web Interface: (a) texts stored in the knowledge base; (b) meta-information associated with a content

HTTP method	path	description
GET	/contents	Search contents
GET	/tts	Text To Speech
GET	/tts/<content_id>	Content Text To Speech
GET	/search2tts	TTS from content search

Fig. 4 - Endpoints for retrieving content from the knowledge base

competitive positions in innovation but expose investments to obsolescence risk. Establishing and maintaining a relevant presence in the current and foreseeable cultural heritage metaverse is then a managerial and technical challenge. Reducing the obsolescence of digital content (videos, photos, 3D models) and allowing the reuse of existing digital content while gradually producing more advanced formats can be very useful.
In the IDEHA project, CNR and Engineering adopted this strategic drive obtaining technical results that are:

- open and based on standards,
- cloud-native, and therefore very cost-effective,
- horizontally scalable, from single sites to large regions,
- able to manage the life cycle of digital content, reducing its obsolescence and facilitating its reuse.

The IDEHA system can flexibly repurpose digital CH content, extending its life cycle by adopting standards to produce and preserve it, making it easy to create XR experiences that leverage digital content realized over time. Our current prototype features the possibility to define and deliver XR (immersive, interactive) visit experiences, featuring:

- immersive digital content, such as 360° photos and videos, enriched by overlapping interactive elements, adding complementary audio and video, multimedia windows or panels, and links to other interactive scenes,
- multilanguage ML-optimized Text-to-Speech audio descriptions,
- seamless integration of XR experiences with traditional multimedia stories,
- optimized delivery: high-resolution immersive pictures and video (up to 16384x8192 pixels), automatic adaptation to the user device (in terms of language and display resolutions), transcoding for optimal media delivery (basis texture formats for immersive static scenes, MPEG-DASH, or HLS for video scenes)
- reuse of all digital content, immersive or traditional, maintaining the possibility to refine and update each item on its own while merging them "on the fly" in the overall experience,
- html5 output containers to be used in websites, mobile apps, or virtual reality applications,
- Artificial Intelligence models to reduce the obsolescence of digital content.

TEXTUAL CONTENT MANAGEMENT

The viewer described so far was conceived and created for managing and perceiving multimedia contents. Nevertheless, the different kinds of data produced in the project, in particular the semantic elaboration of texts, arose the need of adding a specific service to make textual materials as enjoyable as pictures and 3d models.
One of the most natural ways to deliver cultural content is in natural language, particularly through speech. Therefore, enriching the fruition systems with audio contents that describe the artworks and/or the environments that are visited represents an added value.
To this end, a microservices platform has been designed and developed to provide text and audio content when keyword queries are made on meta information.
The platform allows the definition of a textual knowledge base and the organization of information through meta-information (tags described by a key-value pair) which will be used for the recovery of the texts. To facilitate use, a user-friendly web interface has been defined (Fig. 3) that is useful for managing and creating contents, and REST API services that allow the retrieval of the contents through program, so it can be integrated into any software platform (Fig. 4).
For the generation of the audio content, a Text-To-Speech (TTS) service has been defined which allows us to obtain a vocal synthesis (audio stream) of the stored texts.
The implemented service is an abstraction of TTS, that is, it defines a generic interface to which it is possible to connect and then use third-party services that perform speech synthesis. In the proposed implementation, TTS Google and Amazon Polly were added to the service.

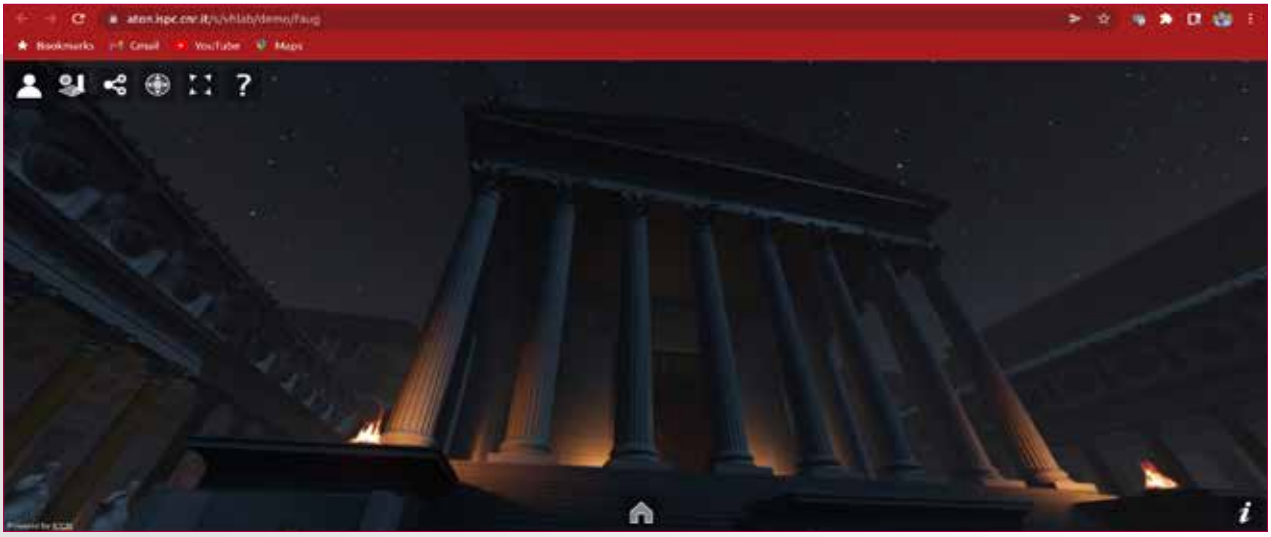

Fig.5: The ATON framework (snapshot representing the 3d model of the Augustus Forum virtual reconstruction)

The adoption of a Microservices architecture has made it possible to obtain a highly scalable and integrable system, oriented towards real-time interaction environments. This latter issue is particularly relevant in the context of the IDEHA project.

FUTURE PERSPECTIVES AND MULTIPLE VIEWERS INTEGRATION

Looking forward, the system may be improved in different ways. One of the main ones is the interaction with other viewers and browsers. In fact, any interactive icon in the 360 panorama may be conceived as an URL, moving the user towards a different viewpoint, also generated by another framework. In this way, different viewers, with their own peculiarities may be connected.

The interactive 360° viewer was developed focusing on the capabilities of high definition 360° shooting, allowed by the last generation spherical cameras. Thus, the movie player skills of the system have been considered as fundamental, instead of other kinds of functions, such as browsing digital models in a 3d environment. Nevertheless the “time machine” function, allowing the user to observe the same landscape in a different time, is a further good task to achieve.

Since some ten years, the ISPC-CNR has been developing the ATON 3d framework (http://osiris.itabc.cnr.it/aton/): open source, cross-platform, working without plugins and, again, compatible with all html5 media formats (Fanini et al. 2021) (Fig.5). Such a tool resulted as a very smart tool for 3d reconstruction of past environments and, generally, interactive visual storytelling (Palombini and Fanini 2019, Fanini et al. 2019).

Differently from the IDEHA viewer, ATON is mainly conceived for 3d landscape browsing. The next step is then the connection of the two frameworks, in order to allow, from the HR 2D movie player, to reach the reconstructed conditions of the same context, modeled and placed as to be reachable from the same position.

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Abstract

IDEHA (Innovation for Data Elaboration in Heritage Areas), is a PON project coordinated by CNR, aimed to an open platform for real-time aggregation of Cultural Heritage elements (sites, monuments, etc.) data, and their "packaging" in sets of informations for different targets of outlined public. The main tool conceived for displaying data (spread from different sources: news, digital libraries, IoT, etc.) is an immersive viewer capable of displaying 360° images and videos, all multimedia inserts html5-compatible, and multi-language audio-synthesized messages. Such a tool is presented here. It has been planned thanks to the effort of CNR and Engineering, and will be released in order to become a trigger of further initiatives both commercial and free.

Keywords

Cultural Heritage; 360° photography; semantics; interactivity; immersivity

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