

Carsten Busch / Christian Kassung /
Jürgen Sieck (Hrsg.)

Kultur und Informatik: Mixed Reality

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Kultur und Informatik

Mixed Reality

vwh

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Augmented Reality to Evoke a Site at the Origin of the Information Technology Age

Case study on the Guglielmo Marconi's Radio Station in Coltano, Pisa

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Abstract

Guglielmo Marconi brought on his experiments obtaining the first radio transmissions in Coltano, near Pisa, in a radio station opened in 1911. Nowadays in that place it is possible to see only some ruins and the traces of various large antennas. To face this poor condition and to discover back the site, a specific research has been started, focusing the efforts in the try to give back a sense of place and proposing a system of interventions integrating real/digital elements into a possible plan of restoration. After a first digital survey of the area, this research started to develop reconstructed 3D digital models, giving large importance to an augmented reality experience, capable to bring back in place the colossal antennas and guiding the visitors to the value of this place.

1 Introduction

Wishing to find one of the starting points of the age of information technology it is possible to identify one of its beginning in the early XXth century, with the first attempts of wireless communication. In the first “traditional” radio communication it is possible to see the very first start of the ongoing revolution in information technologies: a sequence of steps, made here and there in the world brought little by little to our multimedia and “real time” system of communication. Technology is something ever-changing, all that is left behind easily becomes old and decay. In a certain way this was the destiny of the settlement former directed by Guglielmo Marconi in Coltano near Pisa (just two kilometers from the Airport of Pisa). Thus, even after World War II destroyed the high antennas built there and the architectures entered a long period of decay, this area remained on the borderline between being a total lost and a fascinating presence. The structures were left to themselves and used for improper activities, depot, social activities and when the decay began to compromise the safety of the building: completely abandoned. None of the intentions about some recovering never succeeded in neither a minimal part. Thus the potential strength of this place is present but barely perceived in the proposal of restoration appeared in time. The importance of the place will be nothing without an approach putting the technologies at the first point in the renovation of this area, or there will be the risk of betraying the real sense of the innovative and scientific genius once moving between these walls.

1.1 The story so far

Guglielmo Marconi (1874–1937), inventor, scientist, politician, a pioneer man and pillar of wireless technology, Nobel Prize for physics in 1909, identified in Coltano, which was a real estate at the beginning of the XXth century, the ideal place for the realization of one of the first ultra-powerful radiotelegraph for colonial and transoceanic communication, potentially capable of communicating with Argentina [Ciabat1995].

The estate of Coltano, at the beginning of the XXth century, resulted marshy, with altitude near to the sea level, and its landscape was in contrast with the two next cities of Livorno and Pisa [RuMa1997]. The radio-towers were located in the so-called *Padule Maggiore* and *Padule del Porcile*, and both were near to the main historical architecture of this area: the *Villa Medicea*,

built in the XIth century, developed in the XVIth century and expanded and transformed in the XVIIIth century [Simoni1911].

About the importance of this experience, the words from Marquis Luigi Solari, a trusted man and collaborator of Marconi, sound very significant: "The most important part of the history of radio in Italy with all its technical, economic and political vicissitudes, took place virtually in Coltano" [Solari1939].

In 1903, Vittorio Emanuele III, King of Italy, receives Marconi in San Rossore, Pisa, to grant him, free of charge, with the site of Coltano to build structures for the radiotelegraph scientific research; such a marshy zone was ideal for the purpose of long-wave transmission because the dispersion was minimized [Valluri1924].

Gradually the main building began to rise on the site, the original site received several changes during this phase, the erection of the first transmissions towers, radio-reception houses, as well as depots and housing for the officers and streets. At the end of the first decade of 1900 there was the realization of a second station; in November 1911, the station began to be connected to Massawa in Eritrea and Glace Bay in Canada. The whole set of electric machinery was supported by two groups of 200 kilowatt alternators, transformers carrying the tension from 2000 to 10000 volts [Solari1928].

Throughout the years some important communications have been found and they deserve to be mentioned: the first messages to the colonies of Africa and in November 19, 1911, during the inauguration at the presence of King Vittorio Emanuele III,, Marconi wrote to the director of the New York Times: „My sincere greetings transmitted by wireless telegraph from Italy to America. Coltano, Pisa hours 5:47 pm“; It is also worthy of mention that in October 1931 with a push of a button from there he turned on the radio signal that enlightens the statue of Christ the Redeemer in Rio de Janeiro. The "Marconi" Radio Telegraphy Station, one of the first in the world, was located on *Poggio di Corniolo*, it was designed by the scientist himself; the realization of the first project began in 1904 and the physical realization has been modified during construction through various steps based on the requests of the Marconi's Company. Changes which were made mostly apart from the original project; Civil Engineers inspections in 1907 and later on, were then rectifying situations of fact that in other cases would have been considered irregular [Lions2004].

The main changes to the initial plot concern increases in the central compartment heights, in the sizing of the walls, in the coverage that became terraced

with a continuous parapet enriched by a balustrade of concrete columns and later again changed into a pavilion roof. Other alterations were the addition and later the removal of a large plate in cast iron with the Savoy emblem (nowadays completely disappeared) and the replacement of the large windows in the central hall and the substitution of the ceramic tiles on the floor with concrete ones.[ArchSPI]

From the architectural point of view the building has a typical neoclassical style, recognizable by the statements with smooth ashlars, a common element for the eclectic language in use at that time, with fine moldings all along the arched windows and cornices. The general plot is "T"-shaped, with the central square building housing the main rotating disc generators machines, and the rectangular shaped area leading to the building with the offices; the fronts of the building bring the signs of Annibale Biglierie, a civil engineer in Pisa. The approval from the Superior Council of Public Works is dated 1907. [ArchSPI]

The development of the towers, a group of eight called "Eritrea" and the second equivalent group called "Canada", were growing according to an axis one kilometer long. They had the shape of iron trellis recalling the well known Eiffel Tower, and culminating with a long wooden pole of Weymouth Pine. The total height of each tower was about 75 meters.

They all could communicate with each other by means of a large aircraft wire, the electrical energy was transmitted to them by the electro-generator machinery placed inside the station; the project of the towers shows the basic dimensions of 8.00 x 6.90 meters placed 2 meters above sea level, grounded on concrete foundations of crushed and hydraulic stones [ArchSPI] (See Fig. 1).



Fig. 1: 1911, Coltano landscape and skyline with towers, radio station and marshy area

1.2 A long period of decay

Stazione Marconi is currently in a state of advanced decay, abandoned and damaged by the vagaries of time, vandalism and carelessness; however, its static integrity is acceptable, except for many elements of the roofs that are broken and unstable.

In the last years the area has been surrounded by an one-meter-high metallic netting, fixed on wooden poles, a try by the municipality to prevent trespassing, vandalism and abusive settlement, and to prevent imprudent visitors from possible injuries.

The decay of the building is strongly ongoing, amplified by the growth of vegetation: the walls are vastly covered by ivy and other climbing plants, with resulting damages to plasters and decorative features; some fig trees grew

inside the building itself, reaching and damaging the roof structures. As a consequence of the uncontrollable vegetation growth, some areas are almost inaccessible.

The outside and inside of the building show various degradation forms: erosion caused by weather conditions, breaking and loss of stone and brick elements are common and evident.

Roof structures presents some cave in and deformations, due to loss of wooden structures integrity and breakings due to the aforementioned fig trees. Metal gutters are heavily eroded or missing, as for the windows fixtures, damaged both from vagary of times and vandalism.

In many rooms the floor is covered with debris from the collapses, earth and bird's guano, this favours the growth of vegetation; Tractor tires, threshing machine components, rusty and abandoned, decayed toys, broken bottles and every kind of waste spread on the floor, as a sign of abusive dump function found for some insane reason in the *Stazione Marconi*.

In the last 15 years the local community tried to focus the attention on this area, and some of the damage could have been prevented with a preventive action by the proprietor itself (the area belonged to the National Demanio for a long time, then, in recent time, it has been passed to the local municipality), avoiding to reach the current state of decay. Thus no real intervention was done until now. It is worth to say that in its current condition the building is highly dangerous, with many parts, mostly from the roofs, at risk of falling or collapsing. [Paglia2000]

2 The Survey Campaign

The Survey campaign answers the need to produce a reasonable and reliable graphic representation of the building, over a century after the planning and construction of the building. No accurate survey was available previously. The state of decay of the building creates some obstacles to the direct survey methodologies, impossible where the growth of plants prevents access. The instrument used for the survey was leased from the Laboratory System of the "Dipartimento di Architettura" (DiDALabs), from the Florence University. It is a Z+F (Zoller+Fröhlich) imager 5006h, a phase shift 3D laser scanner, a fast and reliable measuring machine, capable to get points up to a distance of 80 meters and with an accuracy of around 2 millimeters at a distance of ten

meters. Mounted on a topographical tripod it was in the correct condition to operate inside a difficult subject like the heavily damaged station.

Most of the scanning stations were operated using the “high mode” setting of the scanner, to achieve a good detail level, required for the decorative features of the buildings, to keep a reasonable distance from certain dangerous parts and resolve the need to correctly take the measurements of temporary targets and small details around the ruins as a system of reference in between a real invasion of trees, ivy, grass and other vegetation.

The survey with the 3D laser scanner took a whole day, totalling 76 scans from the outside of the western façade, to the northern facade, through which the central hall was reached. The southern and eastern façades closed the data collecting process; North and East facades were heavily covered by vegetation, so the survey of these parts was incomplete, even though a recent operation of cutting off the plants laid open a certain sector of previously infested walls, so it is now possible to plan a partial new survey, to integrate the first one.

The alignment of all the scans (originally in ZFS format) was done with Autodesk Recap 360 pro, which processed all the scans in a single session, almost automatically (just a few sets of scans were in need of manual intervention, most of the time because of some differences caused by the wind between the generous vegetation), giving back a global pointcloud of the Stazione Marconi in RCP (Recap) format.

Using Autodesk AutoCad 2016 and its possibility to connect and operate directly on the RCP format the pointcloud was imported to obtain plan views, sections and elevations of the actual condition of the Stazione Marconi, to obtain a first reliable base, after a century of perfunctory drawings. For some specific needs (like an easier reading of the section lines between foliage, ruins and trash) a version of the pointcloud was imported inside Bentley Pointools, a software offering some very interesting features for better managing the pointclouds and extracting in a very practical way images and animated sequences from the pointcloud data (*See Fig. 2*).

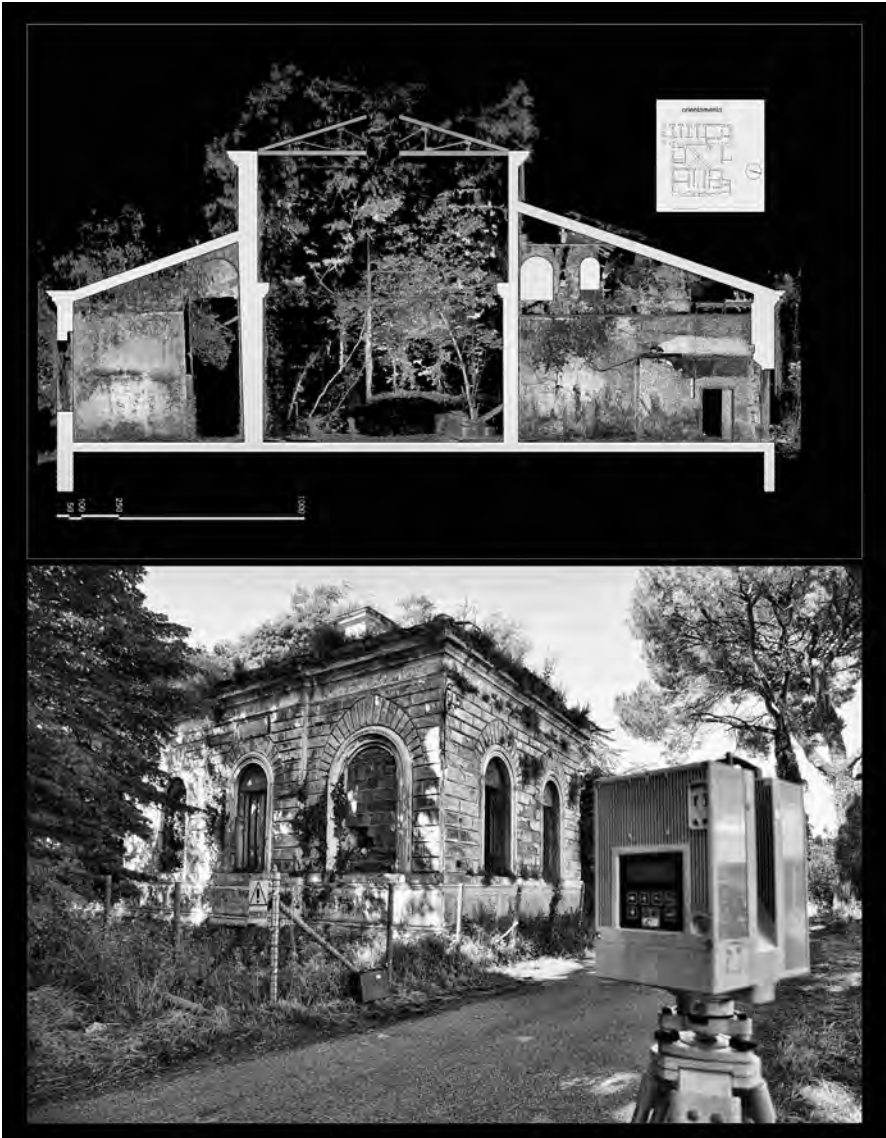


Fig. 2: 3D Laser scanner survey and Point Cloud inside Bentley Pointools:
Section of the destroyed structure

3 3D Reconstruction

Every digital reconstruction starts with a data collection phase in which the main objective is to gather information to support the modeling process. Besides traditional tools, on-site measurements and data collection, 3D laser scanning technologies and photogrammetry techniques have become mainstream in the last fifteen years. Often, in archaeological reconstruction, there is neither a picture nor a detailed description of the original palace, and the excavation did not provide enough facts to establish a scientifically valid model. For the Marconi Station, on the contrary, it was possible to achieve a faithful reconstruction, built not only on data arising from the laser scanner survey, but also from the original project drawings and a lot of historical photos, videos and documents. All these bases allow to elaborate hypotheses and evaluate them directly through 3D modelling. [Cacia1998]

The 3D reconstruction process is constituted by several aspects and steps: modelling and shape reconstruction, reduction and balancing of detail such as polygon reduction and mesh optimization, visual and light appearance with texturing and ambient occlusion, and other topics related to the challenges in development of AR and VR three-dimensional browsing. Technical choices and visual results will contribute to define the technological framework mainly based on mobile systems, aiming to offer a realistic virtual experience in order to appreciate this Architectural Heritage.

Mcneel Rhinoceros 3D was used as main software for developing a surface model of the building. Starting from the original drawings and combining them with laser scanner data the basic structure of the reconstruction was modeled. The refinement and the final texturing were done directly from the photographic survey campaign. The level of detail and objects organization are strictly dependent on the final aims of the project.

In Unity 3D it was possible to develop the environment, generating a realistic terrain from heightmaps. It is possible to download a real world satellite survey height map from the website Terrainparty (<http://terrain.party/>), which simplifies the method of finding and importing heightmap data for any spot on the globe. The exported terrain model was edited to add textures and trees on it, to bring it back to the aspect it had at the time of the radio station according to the historical photos and videos.

4 Using the 3D Model to bring back the first radio station

Restoration will never recreate the perception of the original radio station system, with its towers, marshy lake and iron cables up in the air, at the beginning of the XXth century.

The goal is to communicate a reality that no longer exist of the *Stazione Marconi* at its beginning through a modern technology system. For this reason a system of Augmented and Virtual reality is used to create a memorial milestone, which, at the same time is a dissemination tool and a disclosure of information.

The result of the digital reconstruction process can often represent the starting point of further work that may have several purposes. Diverse multifaceted uses can be identified for a 3D digital reconstruction. On this basis, the proposal is the use of Augmented reality applications overlapping the virtual model on the real site using a portable/wearable devices. The use of game engines and Virtual Reality device allows to navigate and to explore the reconstructed buildings in a virtual environment; including interactive components and metadata, but also recreating the lost environment in an immersive perception.

The dissemination represents the last phase, but not the least important; it can be the main aim of a research project or its final step, where the results of the applications and analysis of the 3D digital reconstruction constitute the main outcomes useful to spread the information to a wider audience for different purposes such as cultural tourism and education.

5 From the 3D Model to Virtual Reality

The main challenge, after the previous modeling phases, is to provide smart tools to enjoy the digital reconstruction. Computer graphics techniques have demonstrated to be effective in increasing the value of cultural heritage. These potentialities should be utilized appropriately, by developing an integrated package of services for improving the visitor experience and enjoyment.

As told, Augmented Reality could be the most appropriate tool for our goal. The AR system is the integration of a computer generated 3D model with the natural environment or an architectural context in real time. This enhanced

version of reality can be viewed through several devices, such as head mounted devices. One of the major fields of application of this technology can surely be useful for scientific dissemination in archaeological subjects. In fact the contribution AR gives in this field can increase knowledge-based experiences about Cultural Heritage. The user experience can be improved by imaging the architectural ruins with the ancient landscape, providing non-expert users with useful and effective instruments for the knowledge of artistic and architectural vestiges.

The purpose of this work is to apply the present approach to the Coltano Radio Station, in order to bring the visitors back into the historical landscape where the Radio Station was placed. The aim is to augment the whole area using our 3D models together with other interactive approaches, turning the exploration of these unknown spaces more accessible and enjoyable [Csl2012].

Nevertheless it can be problematic to plan a first person augmented reality experience in the area around the Radio Station, due to the huge size of this complex. To further explore the whole area could be difficult due to the current condition of the terrain, where wheat is cultivated today. The visitor would have to cross this tricky terrain for kilometers, sometimes inaccessible, to be able to see up close and in Augmented Reality the towers or the station. Moreover the state of abandon of the structure makes the access impossible. The two main problems are due to the centenary disuse of the building leading it to ruin, and consequently the growth of vegetation that hides all the structures.

For this reason our project provides to create a panoramic position from which the user can have a good view of the whole area. So, the first step has been the choice of a definite place that can be easily approached by everyone. A key element was identified in the area, in order to set the rigid support: a bridge made of bricks and stones, measuring two meters wide and nine meters long, crossing the “Fossa Fonda” rural canal. From above this bridge it is possible to see the station and the bases of the towers [Bert1922]. This is the perfect place for experiencing a 360° virtual tour. This bridge is halfway among the Marconi’s Station and the ex-radio receiving station, today wrecked. At about 250 meters away from the main station itself, the receiving station was originally built to create a pedestrian passage on the Padule Maggiore, before his restoration, to reach the tower number 8 of the so-called “Lato Coloniale” [Bert1922].

The choice of this bridge has multiple reasons, such as the allegorical meaning of the actual information passage, wishing to give back architectural and functional pride to a previous important structure, unusable because of its condition.

On the bridge a panel is installed on which the target and a QR code are printed (See Fig. 3).



Fig. 3: QR Codes Panel, invented for AR/VR experience, and dissemination of general information of the area, such as videos, articles and ancient images

From this point the virtual experience starts. By simply scanning the QR-Code, the user can download our mobile app. The application is structured in two parts. The first one is in augmented reality, it allows users to interact with the panel. For exact tracking we use image-based techniques [ScHol2016].

The software renders in Augmented Reality some historical information about the station and its functioning above the panel: texts, historical images, historical videos and the 3D model of its reconstruction in scale (See Fig. 4).

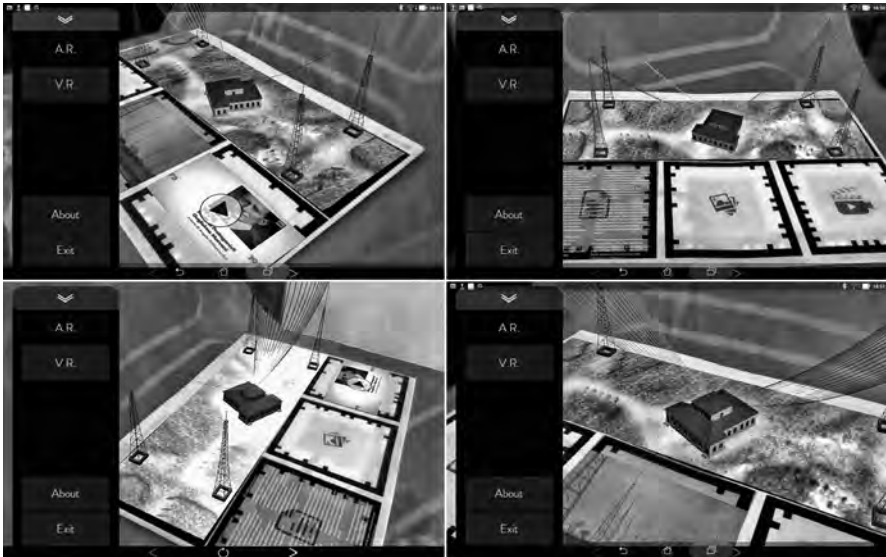


Fig. 4: A.R. Experience on the panel, with historical images, videos and 3D model

In the second part of the app users can enter inside the virtual reconstruction of the entire environment in VR mode. With 360 degree renderings we built a panoramic video, using Unity3d. This allows everyone to explore the whole area by staying comfortably in place [KipRa2012]. In the video the 360° camera moves across the 3D reconstruction, virtually carrying through the towers to the station. Wearing Google cardboard, or other VR viewers, the experience increases its realism (See Fig. 5).



Fig. 5: V.R. Experience: here a frame of the video, with the reconstruction of Marconi Radio Station at its beginning

A full panoramic tour of the area allows us to perceive the clear transformation undergone by Coltano in the last hundred years (See Fig. 6).



Fig. 6: V.R. Experience with Google Cardboard

6 The idea of a real/virtual museum

The situation of this particular built heritage is quite dramatic, many parts seem beyond any possibility of architectural recovering, but the sense of the place, its particular relationship with landscape and with the story of technology is still present and strong.

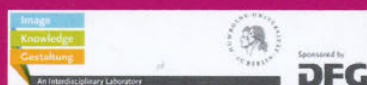
As the reason of its building has to be found in the will of scientific progress and continuous innovation, in a similar way, new technologies of simulation may work, enhance the understanding and create a connection between what this place was and its meaning, bringing the surprise of the high antennas, of the great arches of the wires, of what was happened between these walls, of something that cannot be recreated and is to be considered as definitively lost, but can be evoked in our contemporary technologies. The creation of a “new reality” for Coltano and for the Stazione Marconi is a possible step forward recovering, while even if a place decays and is at risk of destruction, it is very important to keep its trace, disseminate its best value and create the condition and the tools for starting reflecting about a real and intelligent recovery.

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The central questions of the conference *Culture and Computer Science 2017—Mixed Reality* include the analysis, design, use, advantages, as well as challenges of hybrid objects. In this context, museums are not only static memory spaces for material objects plus some selected and hence also static knowledge. The key challenge for tomorrow's museums rather is to create flexible constellations between collections, research facilities, museums and exhibition spaces, in which objects are modelled as hybrid, (inter-)active structures in order to circulate them, to aggregate and to evaluate the resulting data.

Within this conference volume, the implementation of hybrid objects in mixed reality environments is explored and the theoretical fundamentals and best practice examples of their strengths, weaknesses and innovative content are discussed. It addresses professionals working within cultural and creative industries, communication and cultural scientists, designers, artists as well as computer scientists and engineers, who conduct research and development on cultural topics.



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