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Otranto in the Middle Ages: a Serious Game for the Edutainment

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Abstract—**The MediaEvo Project aims to develop a multi-channel and multi-sensory platform for edutainment in cultural heritage for the realization of a digital didactic game oriented towards the knowledge of medieval history and society by means of the integration of human sciences and new data processing technologies. During the project it has been possible to test the possible interactions between historical research, morphological inquiries, data management systems and the definition of a virtual immersive platform for playing and educating. The platform has also proved to be a means for validating hypotheses and findings formulated by researchers. This paper introduces the theoretical questions related to the educative use of Virtual Reality technology and describes the steps of the reconstruction of the town of Otranto in the Middle Ages: data collection and integration, new historical acquisitions, organization of work, peripherals and software applications.**

Index Terms—***Edutainment, 3D Game, Virtual Reality, Virtual Cultural Heritage***

I. Edutainment and Virtual Reality

While new treasures emerge from places previously unexplored or ignored, a larger number of buildings and sites are compromised by natural or human action. It's a widely held point of view that cultural heritage is diminishing continuously. This process leads to the demise of important historical documents and artistic goods.

The improvement of our technological capabilities enriches the possibilities for research and protection and enhances the value of cultural heritage, thus halting their demise. Firstly, the increased speed of communication and data exchange within the research community offers the dimension of real time interconnectivity.

Secondly, the overall amount of information originating from both qualitative and quantitative exploration with the support of technologically advanced equipment, compared with that of a few decades ago, leads to the possibility of an extremely detailed description of reality.

The systems for cataloguing and managing these data have been structured with complex and ontological categories that define common protocols for enhancing classification and comparison even among distant users. In information technology, the term ontology refers to a "specification of a representational vocabulary for a shared domain of discourse - definitions of classes, relations, functions, and other object".

"When the knowledge of a domain is represented in a declarative formalism, the set of objects that can be represented is called the universe of discourse. That set of objects, and the describable relationships among them, are reflected in the representational vocabulary with which a knowledge-based program represents knowledge. Thus, we can describe the ontology of a program by defining a set of representational terms." [1].

Finally, what really can represent the overall sign of the time, is the possibility presented by the technological means for a realistic representation of everything that comes from research, from the hyper sensorial reproduction of reality to the virtual reconstruction of different hypotheses and scenarios.

The expansion of these means necessitates a contextual disciplinary revision, in the interest to all those in the field of humanistic studies. Historians cannot afford to buck the trend to a post-literary dimension of knowledge transmission or knowledge itself [2].

The new phase of contemporary civilization has been defined post-modern or, more correctly, post-historic, for the predominance of representation and hard virtualization of reality.

Almost forty years ago, Jean Baudrillard theorised in the 1970s about the overcoming of the historical era for a still undefined "post", in which all distinctions between reality and representation would be erased.

In all social aspects, particularly those relational and educational, he predicted that the virtual would overtake reality with an infinitely reproducible hyper-reality, simulacra of things to the limits of perception that is to say death [3]. From his perspective, hyperrealism is much more attractive than realism, the virtual world is going to overcome the reality, simulacra are going to be better than things.

Evolution in research methodology corresponds to a general debate on communication and education closely linked to the characteristics of a changing perception of teaching, oscillating between experimental impulses and conservative attitudes [4].

II. The Ancient Town: Research, Representation and Education

There are many different methods of analysis, interpretation and communication using digital technologies. Geographical Information System (GIS), remote sensing, laser scanning, photogrammetry, computer vision, 3D modelling, Virtual Reality (VR) and Augmented Reality (AR) are instruments of a multidisciplinary system that links historical knowledge, structural recognition, geotopography, geology, sociology, urban and architectonic analysis, engineering and graphic skills.

The ancient town, as an information unit, can be defined as

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a cultural unit code that locates and describes the process of territorialization of human society. It is the space-time relation between man and environment at a certain time. But the educational purpose of the work requires a perceivable synthesis of culture, civilization and place [5].

The virtual reconstruction of a historical landscape is divided in five levels. The first level (Archaeological Landscape) regards all the information coming from physical measurement (we can call it Realscape). The second level is the Interpreted Landscape or Mapscape that is defined by the systematic organization of data. The third one is the hypothesis of a possible landscape in the past (Ancient Potential Landscape o Pastscape). The fourth level involves the experience of historical context through a process of immersion that defines contemporary perceptions. With the aid of the social sciences this leads to the definition of Perceived Landscape or Mindscape. The final level is the Webscape, the grid of outer relations and communication that is useful to test the process and collect the necessary feedback [6].

Until recently, the "historic vision" was limited to only a few professionals, scholars and researchers, who share the interpretation codes for extracting the ancient landscape from the actual one. In this new stream of experimentation, geared towards interaction and edutainment, the researcher finally becomes part of a system through which to study and interpret space.

In a virtual interactive town, the possibilities of information exchange increase dramatically from static reconstruction to simulation. Simulation allows the construction of a platform that adds the definition of game rules and plots to interaction and immersion. This allows players to easily experience and recognize topographical and temporal coordinates of virtual space. In this way the past is actualized with real behaviours, combining the vision of Pastscape and Mindscape in the virtual reality built on Realscape and related to the Mapscape.

The recreation of a historical city, therefore, belongs only partially in the historical dimension in as much as creation depends upon rules and sensitivity. It opens up the field to a real design condition understood as “universal attitude”, creative knowledge of the relationships between construction and organic matter.

The categories that are part of contemporary urban living are inseparable from those of the historical urban landscape. There are constants in settlement which are a result of the general characteristic of the relationship between man and environment; others fall into a more comprehensive exclusivity of localization which is characteristic of the different indigenous cultures (called *milieu*: a permanent combination of socio-cultural settlement characteristics in a particular geographical area through a historical evolution of relationships between subjects, which in turn relate to the way of utilizing the local natural ecosystems).

For every one of these constants there is a distinguishing characteristic that stems from a primordial interpenetration of *topos* and *oikos* and develops according to a network of endogenous and exogenous interactions that the urban environment goes through in the course of its life. The general categories are highly representable and make the underlying logic visible to a user’s eyes.

The cultural singularities are, on the other hand, the frontier of the reconstruction, the *genius loci*, whose representation is still difficult to express on an immediate and empathetic level.

According to Lynch's theory of the Image of the City, "to heighten the imageability of the urban environment is to facilitate its visual identification and structuring a city is a multi-purpose, shifting organization, a tent for many functions, raised by many hands and with relative speed. Complete specialization, final meshing is improbable and indesirable".

Figure 1. View of Otranto (*Idruntum Civitas Apuliae*, Giacomo Filippo da Bergamo)

In terms of educational aims, landscape could then be intended as a form of logical “operator”: both instrument and object of knowledge [7].

The final goal of the definition of the historic landscape is the *Cybernetic World* that will create infinite possible simulations, not necessarily bonded to physical reality, based on the algorithms that encode the understanding of ancient situations.

III. Experience And Interaction in Historical Contexts

Virtual Reality have opened up new possibilities within disciplines which have led on, in the space of only a few years, to develop distinct characters of their own. Nowadays, we speak of Virtual Archaeology, Virtual Architecture, Virtual Town Planning and so on, indicating that part of the discipline which is closely linked to material contexts and specialized in the reconstruction or verification of classical assumptions or new hypotheses. The humanistic disciplines (history, philosophy, etc.) are still some way from this point. Their contribution, however, is fundamental in order to validate all the work in this environment.

In the work of reconstructing historical or archaeological landscapes, extensive experimentation takes place on the net or has been presented during the course of international conferences. These primarily concern the elaboration of algorithmic models in order to better comprehend and reconstruct the sites, technological applications for AR on cultural heritage and ontological systems and data management.

The reconstruction of the site of Faragola (Foggia) by the University of Foggia, undertaken as part of the *Itinera Time Machine Project* [8], fits within the trend of an experiential relationship within an archaeological context. Other applications facilitate access to and reading of the cultural patrimony both within the museum and online: *Appia Antica Project* [9], the *Virtual Rome Project* [10], *Muvi* (a virtual museum dealing with daily life in the 20th century) [11] and the *Nu.M.E. Project* (a virtual museum concerned with the city of Bologna) [12] are all to be considered prominent examples of experience relating to the latter.

On a strongly interactive level and related specifically to multichannel edutainment, examples of applications utilizing Virtual Collaborative Environments (CVEs) are found in the

platform *City Cluster* [13], the *Quest Atlantis Project* [14] and *Integrated Technologies of Robotics and Virtual Environment in Archaeology Project* [15].

IV. The MediaEVO Project

One very effective way to use Virtual Reality in order to teach students about ancient culture is to have them enter the virtual environment as a shared social space and have them role-play members of that society.

The MediaEvo project is a didactic game about the history of the Middle Ages and aims to meet the needs of teachers and students. The project aims to develop a multi-channel and multi-sensory platform in Cultural Heritage and to test new data processing technologies for the realization of a digital didactic game oriented to the knowledge of medieval history and society.

Otranto has been chosen as an example town for its culture and geographical position. Recently the academic world has shown renewed interest in it and many publications and lectures have looked at and partly explained the ancient role of this town focusing on the historical happenings and on the development of urban institutions [16].

The game is intended as a mean to experience a loyal representation of the possible scenarios of the everyday life and activities of the people during Frederick Age (XIII century), describing them in simple language but with the utmost fidelity to history.

The framework has features of strategy games, in which the decision capacities of a user have a big impact on the result, which in our case is the achievement of a learning target. The idea is to provide a competition between the players, during the learning.

The system, on the basis of a well-defined learning target, will continuously propose new paths in order to allow the achievement of different learning results.

In addition, the MediaEvo Project investigates the use of digital entertainment and performance media to enhance the communication of cultural heritage and history in order to increase our knowledge of such a relevant part of our history.

The idea of the MediaEvo Project is the development of an innovative game engine that has to be specialized for an instructive application with multichannel and distributed fruition with edutainment purpose [17].

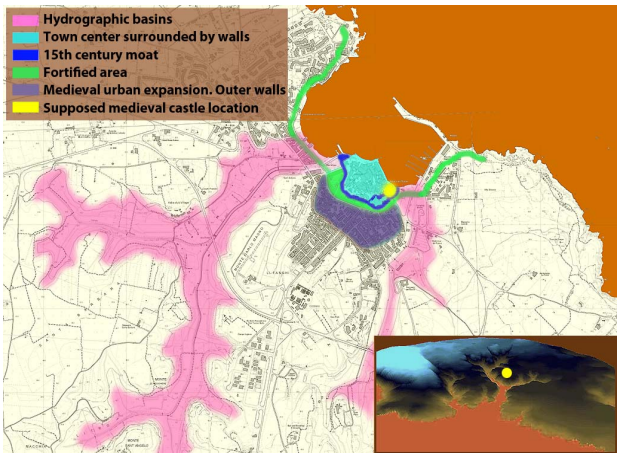

Figure 2. Part of Regional Technical Map on wich are highlighted the hydro geological arrangement and the areas occupied by current and medieval urban structures. Bottom right: Digital Terrain Model (DTM, 5x).

V. The Scenario

Around the middle of August of the year 1227, Frederick the Second of Swabia entered the city of Otranto with much pomp and circumstance. The Emperor, in departure for the crusade to the Holy Land, was accompanying his wife Yolande (or Isabella) of Brienne to where she was to wait (and pray) for his return (Riccardo di San Germano, "*Chronica*", MGH, XVIIII, Hannover 1866, p. 348).

This episode, far from being a historical event, represents a historical and narrative device that allows a series of elements, fundamental for the reconstruction, to be fixed, while at the same time contextualizing them within a highly communicative plot.

Above all, the definition of a precise date allows for the large amount of information which emerges from historical and material research to be ordered, establishing a fundamental reference point for a period as long and varied as the Middle Ages. Secondly, the date is located in a period that is important for local history, for which a vast array of studies and interpretations enrich the communicable cultural baggage. Otranto, located in the extreme south east of the peninsula, was, in the late Middle Ages, relatively modest both in terms of the city dimensions and number of inhabitants.

Its geographical position lends it the particularity, often emphasized by scholars, of having the ancestral condition of cultural bridge between east and west. With its small size and characterized by significant polarity in terms of architecture, landscape and even on a symbolic level, the city demonstrates the close relationship between Mediterranean cultures, particularly western-catholic, eastern-byzantine and Islamic culture. It was a city that was officially bilingual, where along with Latin, byzantine Greek was commonly spoken, used in religious ceremonies and taught at San Nicola di Casole, one of those great centres of cultural preservation and learning which formed part of the monastic scriptoria.

In the maritime and mercantile quarters of Otranto, numerous languages were spoken by the inhabitants; there were colonies of populations settled there in different historical times resulting in a contamination on an artistic and architectural level. Among the various cultures there were certainly Jews (amounting to a colony of about 500 people), Muslims (merchants or slaves), slaves from the Adriatic shore opposite Otranto, obviously the Normans or *francigeni*, but also those ethnicities which had settled as mercenaries to defend the city (Russians, Varangians, Armenians, etc).

This cultural melting pot, with its roots firmly planted in the Messapian and Roman civilizations, produced a particular mix of knowledge and traditions which are still evident today in some of the local customs, in handmade crafts, in figurative art and in the articulation of space.

To research and reconstruct for the purpose of interaction in such a rich context, inevitably leads to the expression of situations that recall the main themes of Middle Ages, in a kind of “little virtual encyclopaedia” that creates the background to the imperial march of the Great Staufer through the city.

VI. Urban Research for The Game

Taking inspiration from the reading of plans of an urban environmental nature, in relation to the high level of recognition and representativeness required for educational and communicative purposes, the research was oriented towards clearly delineating relevant functional contexts on a historical and material level:

- defensive (the city walls and service areas, the castle);
- extra-urban (the areas of expansion, non urban functions: monasteries, storage areas, production facilities);
- mercantile (trade functions and the structures for economic activity: commerce, distribution and warehousing);
- intermodal (the port, the regional arterial roads);
- infrastructure (the hierarchy and function of various axes and the identification of a central city gate-square-city gate system and the mediating connections);
- residential (neighbourhood settlement patterns);
- religious (the diocesan structure concentrated in the cathedral-bell tower-square and in other sacred places);
- handcrafts (activity);
- familiar.

The defensive context, which includes the city walls, the castle, the internal and external garrisons for surveillance and responding to attacks, is to be considered the first context of reference for reasons of both a cultural and spatial nature.

According to contemporary historiography, these are the fundamental elements of the image of a medieval city and they represent the necessary setting in which the actions which constitute city life take place (Fig. 1).

Until the present day, the city has preserved its defensive structure built after the Christian recapture of the city, after their tragic expulsion by the Ottomans in 1480. The age and the impact of this intervention don't allow us to effectively determine the original medieval image. A more circumstantial investigation is required. In relation to the historical documentation, the findings of archaeological campaigns and above all on the basis of the analysis of the urban fabric, some useful considerations can be expressed that are a relevant to the reconstruction.

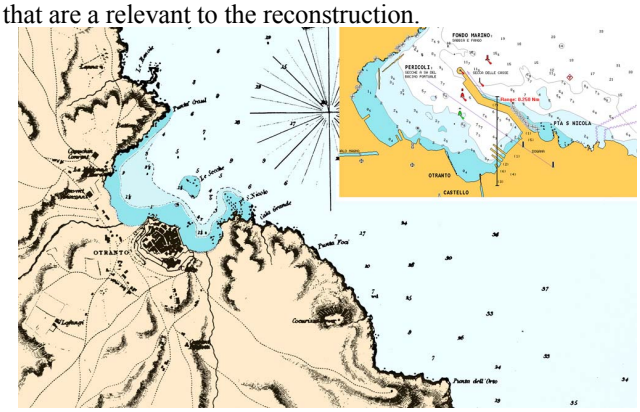

Figure 3. The port of Otranto in the first half of the 19th century (from a survey by Captain W. H. Smyth, 1843, The British Library, London) comparing the contemporary bathymetric state and beacon alignment at the entrance (top right)

The historical centre of Otranto is located on a strip of land between two watercourses. The natural elevation rises to an altitude of approximately 35metres above sea level (in the area of the current cemetery) and falls to an average of 14 metres in the ancient city, fronting onto the sea at 12 metres.

The coastline near the city centre is characterised by an inlet, which corresponds with the two outlets for the water channels and results in a double internal cove that the promontory of land constituting the residential centre overlooks. Between these, the larger of the two water basins, the Idro, is a fundamental element for the entire settlement (also from an onomastic point of view, according to some) for the fact that it guarantees a minimal, continual supply of water in a region which is characterized by an intrinsic lack of surface water.

The geomorphology and hydrology of the site identify a natural system that contains within it and influences the characteristics of the residential centre both on a functional level, in terms of the infrastructure and – above all for the ancient and medieval eras – on a strategic-defensive level

The archaeological evidence reveals a substantial continuous settlement located on the shore of the sea, which dates to the Messapian era, made evident by the surviving fragments of city walls – often reinforced – brought to light in the course of archaeological excavations.

Without going into too much detail regarding preceding eras, for the late Middle Ages one can certainly talk of a city well defended by parallel rings of walls on the inland side and guarded by a system of towers and curtain walls on the sea, organized according to the framework usual in the poliorcetics of that time (Fig. 2).

Figure 4. Ground plan of the historical centre. Identification of the monumental features and urban poles. Tracing of the primary and secondary routes with indications of the orthogonality.Hypotheses of classical-Byzantine atrium-peristyle housing construction. Bottom right: a bird's eye view of the reconstruction in 3D of the present day city.

Between the 11th and 13th centuries the city did not undergo any traumatic events that influenced its form. This meant a structural continuity that substantially supported the demographic fluctuations and functional needs through constant adaptation. Because of the strategic role of the port, extra-urban development occurred in such a way as to assure different levels of defence of the settlement, in order to avoid exposing large parts of the city and its resources to sacking by assailants and to impede direct attack upon the city centre.

The archaeological evidence which demonstrates the existence of an external wall built on the abutments of the ancient pre-Roman wall in medieval times supports the logic of "parallel rings" (according to a logic consistent with continuity and economic rationalism) which were built according to a byzantine model with round towers and curtain walls whose extension is still faintly visible today in the form of the development of the modern city.

Another wall or system of towers, of which there is evidence in a number of pictures, was located along the internal coast of the bay, in order to monitor for and repel eventual disembarkation by assailants.

All this system had to have its fulcrum in the castle, the location of which during the Middle Ages is still uncertain. On the basis of descriptions of the access to the port from the sea written in the second half of the 13th century in a genoese pilot's book, called *Lo Compasso de navegare,* we know that the fort overlooked the sea. The text invites sailors, for their safety, to flank the land, departing from the Cape of Otranto until the point where the rocks below the castle were visible.

The shape of coastline is such that for a ship arriving from the south it will first encounter the northern side of the bay, then the city, starting from the gate at the mouth of the Idro, and finally, the mouth of the canal on the southern side of the harbour. In order to move past the point of San Nicola (upon which today the sea wall closing the harbour has been built) and to avoid running aground in the shallows, it was necessary to use precise visual points of reference, located to the south of the city, and begin to turn while monitoring those points.

It isn't by accident that these rocks below the castle and particularly those further to the south are cited rather than the castle itself because otherwise, due to its height, the tower of the fortress would have been sighted before having completely passed by the shallow depths around the point, placing in jeopardy the safety of the ship (Fig.3).

Figure 5. Schematic plan of supposed medieval Otranto showing the hierarchy and distribution of routes (ancient classic structure ante Middle Ages in magenta; medieval ones according to contour lines in light green), buildings (dwellings in orange, ecclesiastical in light grey, towers in brown), spaces (courts in black, gardens and fields in olive green), fortifications (towers and gates in yellow, walls and castle in red). The scheme is drawn on the actual ground plan of the town (in background white on black) commpared to the 19th Century plan (in blue).

The only descriptive reports that we have of the castrum in the first half of the 13th century refers to the necessity to intervene in order to repair two towers damaged by the sea. This leads us to imagine a fortification exposed to high tides, while at the same time, according to the Compasso also very evident (to the point of being able to use it as a navigation point in order to navigate in the basin).

The present day form of the area between the port and the city, upon that we can hypothesize the medieval castle, was probably heavily modified by the excavation of the moat in the modern era.

From reading the contour lines, from the signs of the quarry and the Bastion of Pelasgi, it's apparent that the original rock face was lowered by several metres, converting the original and naturally craggy slope, which was approximately 7-8 metres above sea level into the present day low lying plane which connects the 15th century moat with the sea.

Further confirmation seems to come from the network of the urban roads (path matrix), which appears to be "oriented" towards what once must have been the 'sea gate' defence for the castle (Fig. 4). The constructed masses were then enclosed within a system of curtain walls interspersed with towers which opened onto the bay where the port was situated; a vital place for the economic life of the city. The castle, with its functional and symbolic value, was the fulcrum of this landscape composition.

Questions connected with the closure and defence of the urban space are tied to aspects that concern the connection of the city with the outside and with the structures of exchange. We know from contemporary descriptions that the main gate of the city opened onto river Idro while the abovementioned seaward gate, opened towards the south. A small gate (*porticella*) – maybe not the only one – probably opened onto the main thoroughfare; perhaps it was a *postierla* or *poterna*, a small passage that connected a part of the city with the surrounding countryside.

Figure 6. Modeling realistic dwellings and furnitures taken from paintings

The image of the city from the land was mediated by a number of churches and monastic settlements outside the city walls, residential suburbs or facilities for warehousing goods or for the production of handcrafts and other goods. The public road that connected the city with Lecce and Brindisi to the north and with Castro and Leuca to the south skirted the external wall of the city, deviating around the city near the port. Along the basin of the river Idro, on the rocky banks, a series of caves that probably date back to the cave dwelling culture of late antiquity or the Paleochristian period opened up. Based on the principle of continual function as seen with other structures, these were probably still in use by the lower levels of the population for housing, shelter for animals, craft making workshops or as deposits for agricultural tools.

The city of the Late Middle Ages, in periods of political stability and before the Saracen raids, passed through a phase of consolidation of its economy of scale based on exchange and the port. Services and specialisation were developed supporting a well-developed social pyramid. This led to a marked diversification in the types of housing, in large part erased by the modern walls and by recent reconstruction.

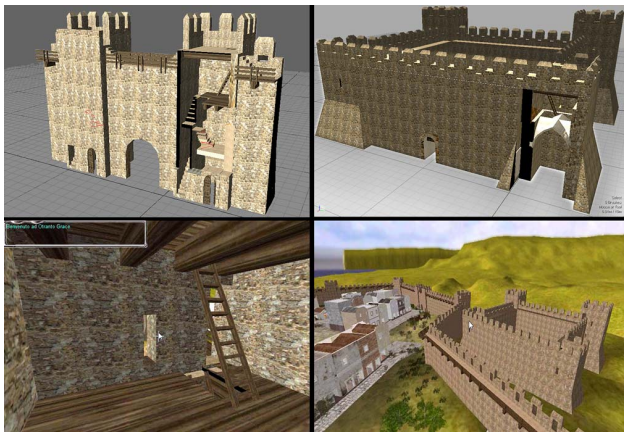

Figure 7. Phases of modeling and importing of a gate and the castle.

For a structural reading of the urban fabric, two ecclesiastical buildings are those best known from the archaeological investigations and studies: the Cathedral and Saint Peter's church, for which functional continuity has been established since the Early Middle Ages. They can be considered the epicentres of well-defined sectors of the city for their importance to the cultural and iconological meme of Otranto.

The urban fabric within the walls presents obvious heterogeneity that is related to the peculiar stratified and paratactic condition of its formation. For the area overlooking the sea, located on a natural raised plane (acropolis), an ordinary, regular, geometric layout, based on the model of the classical Greek-Roman atrium-peristyle house that was widespread in byzantine town planning seems evident.

The reading is complicated in the lower areas where overlapping fragments of structures that resemble the Roman *insulae* model are positioned to accommodate the matrix of paths and natural terraces defined by the natural contours. There are examples of building relating to different settlement logic. Such is the case near the cathedral and bishop's palace that is laid out on a east-west axis in correspondence with the liturgical orientation.

Similarly there is a border area that saturates the area adjacent to the linear northern front of the medieval wall, on which the Romanesque bell tower sits, then enlarged when the walls of the 15th century were erected.

From the 12th century onwards some of these modules were replaced with terrace houses, typical of commercial areas. The basic type of structure in the medieval period, two rooms with vaulting on the ground floor and attic in wood on the upper floors, was based on the model of shop and residence and is found in the historical centre, in scattered agglomerations along the pathways. Other lots, originally atrium-peristyle houses were grouped or aligned later (from 16th century) to make way for the creation of aristocratic residences (Fig. 5).

Figure 8. The reconstruction of St. Peter's Church and its surroundings

Structural reading based on the recognition of logical distribution or relative elementary modules is only one of the interpretive keys available.

The city of Otranto in the Middle Ages was also characterized socially. The scene was brought to life by large or small family groups living according to a rigid subdivision and hierarchy of tasks: travellers who lived in the *xenodochia*; pilgrim beggars on their way to or from the east; merchants and craftsmen; men of religion; *milites* and *pedites*, etc. All these layers overlap to define and characterise the real object of the research opening the field to the endless possibilities expressed by the virtual.

VII. The Virtual Reconstruction

A Digital Terrain Model (DTM) of Otranto site has been produced using ESRI ArcGIS and imported in Torque Game Engine of GarageGames; in order to create the 3D architectural contents we used the Torque Constructor editor of the Torque 3D engine.

Then, we start modeling the first group of dwellings: unit cells surrounded by a rectangular court. This is considered the initial settlement model for all ancient towns.

Figure 9. The interior view of the Cathedral in the game

The second one, by comparison to other similar contexts, is the terraced house unit. Composing and varying those units on the peculiar scheme leads to the reconstruction of the basic urban medieval space in the game. Once defined a list of modular elementary residential net, according to the local medieval unit system, we composed the urban landscape in which monuments, infrastructures and situations have been located.

Torque Constructor has proved to be a sufficient tool for the direct implementation of just elementary 3D graphics models, such as housing and furniture (Fig. 6).

It has many geometrical tools for the graphic processing of the reality context and different controls to select the top of the structure or individual brush model. All units made in the Torque Constructor have been imported into the Torque Game Engine.

Figure 10. The reconstruction of Otranto Cathedral.

For complex buildings and monuments, such as Saint Peter's Church, the Cathedral, we used first a CAM in order

to obtain a more accurate definition of the architectural structures and then we imported these models into the Torque 3D engine.

Modeling the Castle using Torque Constructor, was not so linear: it took much more time than other software, the quality of the model was poor and, due to the complexity of structures, the compatibility with the game engine was not always complete (Fig. 7).

The first monument to be modelled has been the St. Peter's Church, due both to its characteristic of modularity that is useful for testing the software and its historical relevance as unique byzantine building located in a medieval context. In

Figure 11. A bird's eyes view of the settlement.

Fig. 8 is shown the reconstructed scenario of St. Peter's Church and its surroundings.

In Fig. 9 and Fig. 10 are shown two snapshots of the modeling of Otranto's Cathedral and the famous medieval mosaic visible on the internal floor of the church. Other parts, walls and external structures such as ports, complete the original landscape for the game (Fig. 11).

VIII. Missions And Interest Points

According to the aim of developing the edutainment in Cultural Heritage, the building of the urban landscape has been enriched with various virtual interactions into the Torque Game Engine platform.

These interactions have been placed into some checkpoints of the Torque virtual environment; these checkpoints make it possible to trigger particular audio or/and video events during the navigation of the game player.

A novelty algorithm has been implemented to realize a preliminary Artificial Intelligence with the ability to establish stable textual or vocal connections between the different virtual players placed in the game mission.

It is possible to implement the interactions in the Torque platform, allowing developers to bind appropriate actions to a given event. Each event manages a particular action in the game mission and in this sense the events can be used for controlling the collisions with game objects placed in the virtual environment [18].

In addition it is possible to control the movements of each game player in the game mission in textual or multimedia mode.

Even though it may be almost impossible to carry out a proper reconstruction with the current knowledge of the town, what could be experienced in the game is the immersion in a virtual environment that can easily enhance the communication of historical research and understanding of the birth and life of cultural heritage.

IX. Design of the Interaction Modalities And Enjoyment of the Game

In Fig. 12 are shown the main characteristics of the MediaEvo game from the point of view of access and interaction of the avatar-player. The game has been planned with two levels, as it is described below.

A. Level I. Educational

When the game starts (Start), the player sees a multimedia presentation (a videoclip developed by experts in medieval history/art) with a short introduction to the history of Otranto.

Then he can choose the possible destinations (Cathedral, St. Peter's Church, Castle and Town Walls) and see the corresponding videoclips or skip the presentation and start the application. Here he goes to the second level.

B. Level II. Interaction and surfing

This is an interactive level where the player enters the virtual world. He will meet a guide and he could choose to navigate with him - surfing with a guide (level II.1) - or a free surfing without the guide (level II.2).

In the definition of the interaction with the 3D environment in the case of level II.1 (surfing with a guide), two possible scenarios were made and, therefore, two possible tasks for the avatar-guide:

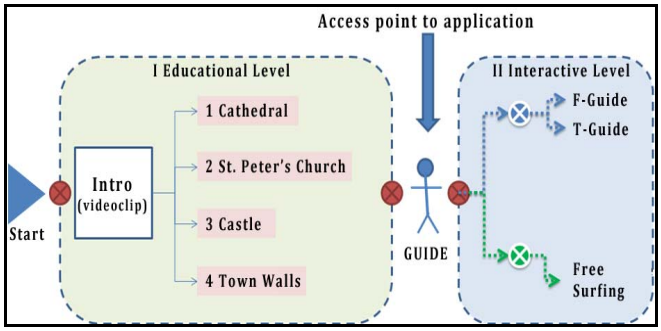

Figure 12. Access and interaction levels of the avatar-player

a) 1st choice: Facilitator Guide (F-Guide)

The guide is a facilitator and he suggests the player to follow a specific navigation path. Such a path has been a planned considering:

- The need to pass by intermediate points of interests that will attract the player in subsequent games and/or for more detailed investigation;
- The shortest distance to reach a specific point of interest.

The prerequisite of such a development is the solution of the technical problems related to the Torque engine and available solutions that allows TGE to perform properly:

- To allow the F-Guide to start multiple paths under player's control to select among the four different choices (IP – Interest Point) - (bring me to the Cathedral; bring me to the St. Peter's Church; bring me to the Castle; bring me to the Town Walls);
- To bring back the guide to the starting point (Ø point) when the player has been guided to his destination (IP chosen), and to reset the F-Guide to be available for the next player. As if the guide, after taking the first player to destination, entrusted him to the guardian for the next interactions. In the journey to destination from Ø point to the selected IP, the guide will not be available for the other players accessing

the game. In this case these players can choose to wait for the guide to come back to Ø point, or to start a free surfing without a guide.

b) 2nd choice: Tele-Transportation Guide (T-Guide)

The player, standing in front of the guide that is always located in the Ø point, can ask to be tele-transported to some points of interest. This option is a learning strategy to turn the player's attention to specific educational objectives. The discovery of other elements in the space "Ø point IP" can be enjoyed in a later free surfing experience.

The technological solution, in this case, consists of:

- Static permanence of the T-Guide in the Ø point, always available for the player.
- Absence of preset surfing paths. This allows for a faster and lighter work charge for the game engine. In the game surfing with the guide, instead, the engine is forced to constantly elaborate complex graphics of buildings and objects along the way, which stress and overcharge both processor and memory.

All interest points have the option to locate the T-Guide

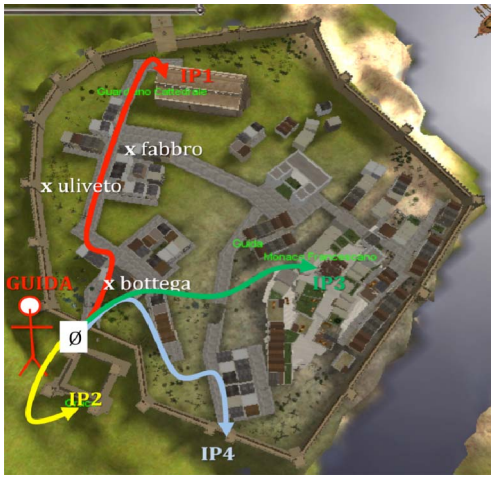

Figure 13. The Interest Points in the MediaEvo game

with the task to tele-transport the player from the IP to another one. Differently from what described for level II.1, in the definition of the interaction with the 3D environment in the case of level II.2 (free surfing), the team conceived a case in which the player, without the help from a guide, can freely move to surf the game. In this case the only helping tools are some "road signs" located at the road intersections to direct the player to the Points of Interest.

Fig. 13 shows the Interest Points (IP) of the game:

- IP1 – Cathedral;
- IP2 - St. Peter's Church;
- IP3 – Castle;
- IP4 - Town Walls.

All the possible interactions between the player and the IP are planned and properly designed. The main ones are:

- surfing inside of the IP;
- surfing outside (all around) of the IP;
- asking the guardian of the IP to tell the history;
- asking the guardian of the IP to view the educational/information library associated to the IP (image collections with notes and characteristics; video clips; documents for a deeper examination, etc.);
- asking the guardian to benefit from tele-transportation to another IP (Fig. 14).

There are also "intermediate Interest Point" (IIP) placed into the TGE MediaEvo, such as the workshop, the blacksmith shop, the olive tree grove, etc.

These IIP will provide more multimedia educational contents for the player (videos, texts, audio files, images).

X. Navigation using the Nintendo Balance Board

The techniques for navigation within virtual environments have covered a broad kind of approaches ranging from directly manipulating of the environment with gestures of the hands, to indirectly navigating using hand-held widgets, to identifying some body gestures and to recognizing the speech commands. Perhaps the most prevalent style of navigation control for virtual environments is to directly manipulate the environment with gestures or movements of part of the user's body.

Some developed systems are based on a head-directed navigation technique in which the orientation of the users head determined the direction and speed of navigation [19]. This

Figure 14. Interaction with a guide (the monk)

technique has the advantage of requiring no additional hardware besides a head tracker, but has the disadvantage that casual head motions when viewing a scene can be misinterpreted as navigation commands.

Another direct body-based navigation technique is found in some systems that use sensors to measure the tilt of the user's spine or the orientation of the user's torso in order to determine the direction of the motion and to allow the decoupling of the user's head orientation from their direction of movement [20]. In the last years have been also developed systems based on locomotion interfaces and on control navigation by walking in place for the navigation in a virtual environment [21], [22], [23].

Wii is the last console produced by Nintendo; it was released in October 2006 and, according to official data of 2010, has surpassed 70 million units sold. The reasons for this success can be found in the new approach that the gaming console gives the user in terms of interaction that effectively makes it usable and enjoyable by a large part of users.

The key of this usability is the innovative interaction system; the Wiimote (word obtained as a combination of "Wii" and "Remote") replaces the traditional gamepad controller type (with cross directional stick and several buttons) with a common object: the remote control. The Wiimote is provided with an infrared camera that can sense the infrared LED of a special bar (called "Sensor Bar") and it

can interpret, by means of a built-in accelerometer, the movements of translation, rotation and tilt. The Wiimote has been equipped with a series of accessories that increase its potential, such as the Balance Board, that, by means of four pressure sensors at each corner, is able to interpret the movements of the body in order to control the actions of the user in a videogame.

Since the frequency of communication between the Wii console and the Wiimote/Balance Board are those of the standard Bluetooth, these devices can be used as tools to interact with any computer equipped with the same technology. Appropriate libraries have been realized in order to allow the interfacing between these devices and a computer. An application of navigation in a virtual environment of the MediaEvo Project using the Wiimote and the Balance Board has been developed.

The aim is to make the interaction easier for users without any experience of navigation in a virtual world and more efficient for trained users; for this reason we need to use some intuitive input devices orientated to its purpose and that can increase the sense of immersion. Because we walk on our feet, controlling walking in Virtual Reality could be felt as more natural when done with the feet than with other modes of input.

For this reason we used the Nintendo Balance Board as input device for navigation that offers a new and accessible way to gain input. It is a low-cost interface that transmits via Bluetooth the sensor data to the computer and enables the calculation of the direction the user is leaning to.

In addition, in order to implement the control of different views and to change the point of view of the user, in our application we used the Nintendo Wiimote.

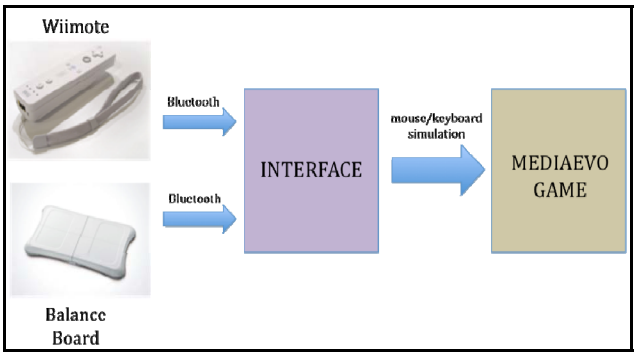

Figure 15. Use of Wiimote and Balance Board in the MediaEvo game.

It is based on a software layer that allows using the Balance Board and the Wiimote as input devices for any application that runs on a computer has been realized. The aim is to allow to receive signals and commands from the Wiimote and the Balance Board and to translate these into commands for the computer in order to emulate the keyboard and the mouse.

Fig. 15 shows the use of Wiimote and Balance Board in the MediaEvo game. The application, created to provide a new system of interaction in the virtual world of the MediaEvo project, can be coupled to any application of navigation in a virtual world.

Figure 16. Navigation in the MediaEvo virtual environment.

For the implementation of the interaction has been used the WiimoteLib InputSimulator, a library for interfacing the Nintendo Wiimote and other devices (such as the Balance Board) in an environment .NET [24].

The library has been used in order to simulate the use of a mouse and a keyboard starting from the properly interpreted and translated inputs received from the Wiimote and Balance Board.

Fig. 16 shows a user during the navigation in the MediaEvo game using the Wiimote and the Balance Board.

The modalities of interaction provided by the application involve the use of the Wiimote and Balance Board simultaneously. In particular, the user is able to move the avatar in the virtual environment by tipping the scales in the direction where he wants to obtain the move; an imbalance in forward or reverse leads a movement forward or backward of the virtual character, while the lateral imbalance corresponds to the so-called "strafe" in video games, where the movement is made on the horizontal axis while maintaining a fixed pointing direction of the gaze.

The Wiimote, however, is used to impart the look direction of the character.

XI. Virtual Treasure Hunt

Within the MediaEvo Project was also developed a “virtual treasure hunt” in the town of Otranto using an iPhone as a device to find and read the clues of the game. The Augmented Reality has been used as an edutainment-oriented technology for the geo-location of the points of interest (POI) and the visualization of virtual information that are overlapped on the video stream of the iPhone camera.

The working modalities of the treasure hunt are shown in Fig. 17.

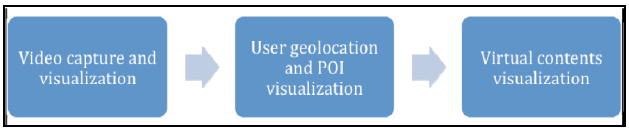

Figure 17. Modalities of the virtual treasure hunt

The main components of the developed application are:

- the management of the treasure hunt manages;

- the management of Augmented Reality information.

These components take advantage of the GPS and compass interfaces and provides the user with a map of the city in order to allow moving in the town and easy reaching the clues.

During the treasure hunt the player can use a radar that provides the location of the POI, and a menu with the possibility to increase or decrease the distance within which the radar can detect the POIs. Once the player is close to a POI, a marker that indicates the presence of a clue is visualized on the on the iPhone screen and superimposed on the images captured by the camera; this is a typical visualization in augmented reality.

Touching the marker in the screen, a brief description of the stage is shown and two new buttons appear in the toolbar in order to visualize a resource available through Internet if the POI has an associated web page and to show the contents (in terms of text, move or audio) necessary to reach the next stage. The user menu allows visualizing the last clue or a map where are shown the location of the player in the town and the location of the next point to be reached.

In Fig. 18 is shown the graphic interface on the iPhone with the visualization of a POI.

Figure 18. Visualization of a POI.

XII. Conclusions

The MediaEvo project has led the researchers to consider some of the issues presented by the multidisciplinary nature of the project and the close correlation between technical and humanistic fields. In particular, conditions were created that put the narrative of historical research to the test in order to produce, in real time, objects, environments, situations and virtual landscapes, thought up in order to represent our stock of knowledge.

Beyond the context of the present reconstruction, aspects of communication and education were examined drawing upon experiences reported in recent literature. Communication and representation are not limited to the pathway of a one-way guided narrative but open up possibilities for the enjoyable elements of interaction and multisensory mediation, which merge object, subject and the experiential context.

As far as the communicative potential of a complete and practical virtual scenario is concerned, a series of properties for the game platform have been defined, such as to render the educative dimension effective.

The final product while responding to historical, technical, and pedagogic needs, presents as open-ended interactive. In its instantaneous perfection, it aims to maximize experience, validating the historical-philological elements and consenting constant checking and updating.

The project evaluates the premises upon which the future development of a historical cyberspace is built and the possibility to produce possible alternative realities to our own reconstructions capable of contextualising past experience.

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