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MareXperience. AI/AR for the Recognition and Enhancement of Reality

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Abstract

The MareXperience exhibition event was held in Procida on February 22 and 23, 2019, inside an ancient cave for the shelter of fishermen's boats, 45 meters long and 8 meters wide. Inside, synchronized video projections and soundscapes were produced to create an immersive virtual environment, whose contents were inspired by the signs and fluidity of underwater life. The digital forms were generated by a Swarm Intelligence algorithm, a tool generally used to create complex kinematic structures defined by a large number of parameters. Generative design is an expressive form aimed at artistic languages and representation of dynamic contexts, which here have been integrated into a narrative process, connecting aspects of the recording of the movement of bodies in water with the principles of data visualization.

Keywords
artificial intelligence, underwater, video projections, generative design, data visualization.

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Theoretical Principles

The digital has extended the ordinary scenarios of research on the languages of the representation of reality, opening it to the complex nature of events, including it in the dynamic mechanisms of the permutation of forms to describe the variable nature of contexts; it has extended the boundaries of drawing, crossing the limits of the languages of representation and finding itself close to the matrices of thought, to its operating mechanisms before words, the text, stop their sense. The extensive fields of artificial intelligence, which now support innumerable actions and choices we make on a routine basis, are becoming more and more widespread, but solutions and tools often show the total absence of the critical processes that should support the evaluation phases, marginalised by improper technicalities in the service of the logic of profit. Yet the virtual was based in thought before taking shape as the result of technology, and in thought it defined the extensive space of the configurations of the real, of the possible, which underlie the variable nature of augmented reality. From philosophy, from Leibniz, from Deleuze and others, those coexisting paths were traced which lead to Turing and Gödel, to the principles and machines that have made possible the current state of technological research.
The concept of the virtual, as defined by Gilles Deleuze, extends the real by opening it up to dynamics of variation, the actualization of which imposes an increase in dimensions and a consistent alteration of temporal sequences [Deleuze 1997; Levy 1997]. This structure requires a complex place to give shape to the images of thought, a virtual space must be traced that includes matrices of relationships between values, meanings, expectations and emotions, as well as rooting it in the perceptive structures of reality, to facilitate the introjections of messages [Repola 2008].

The Project

The project tested a methodology for recording bodies in motion, transferring kinematic parameters into a digital simulation environment, modulating trajectories according to tension fields consistent with the compositional patterns of a virtual space overlapping the cave [Repola 2018, pp. 781-788]. The project started from research activities carried out at the Department of Humanities of the University Suor Orsola Benincasa and the Sebastiano Tusa Civic Museum of Procida, aimed at developing systems and procedures for the three–dimensional survey of seabed and submerged cultural heritage. Real numerical models offer new opportunities of spatial data management for the analysis of places and the simulation of possible scenarios and complex events. Three–dimensional data, moreover, are well adapted to be used in parametric modeling procedures for the development of immersive museums, where scenarios can change according to the needs related to the data representation.
The MareXperience project aimed at verifying a series of interrelation schemes between different digitization procedures of real contexts and solutions for data visualization in an augmented space, given by the overlapping of a segment of underwater life and an ancient cave for the shelter of fishermen's boats on the Silurenza beach on the island of Procida (fig. 1).
In the weeks preceding the event, several underwater video recording sessions were carried out in the Pizzaco and Solchiaro areas to record the movements of schools of fish. Subsequently, the acquired videos were processed in order to provide the numerical parameters necessary to generate the digital animation that composed the artistic performance. In addition, underwater soundscapes were recorded at different depths through the use of a hydrophone. The sound of the sea and its life became the track on which the three–dimensional digital sound integrated with the animations was processed. The latter allowed to place, in a virtual way, sound sources in the space increasing the perceptive levels of the visitors.
The immersive environment [Dede 2009], inside the cave, was realised thanks to a technological system built to project on the long vertical surfaces of the cave the digital video and audio processing produced in the previous phases. In particular, this system consists of a media server, specially assembled for the event, which separated and distributed, in syn-

Fig. 1. Point cloud of the cave.

chronized mode, both the video stream, to 4 ultra–short–throw video projectors, and the spatialized audio stream with 5 independent channels, to the respective 4 active acoustic speakers and the subwoofer.
The immersive installation project has exploited the spatial compression of the place, due to the oblong shape of the cave, to generate in the visitors the unexpected perceptive experience of extension of the places through the movements of the bodies beyond the limits of the long walls. The underwater soundscape, thanks to the techniques of frequency modulation and variable distribution of sound intensity on a spatial basis, supported the depth and three–dimensionality of the simulated space generating an adequate level of immersiveness of the installation.

Software Procedures

The research project, aimed at the construction of a representative protocol able to relate the user and the cultural product through a non–linear narrative logic, used technologies as a tool for the representation of aesthetic language, using machines not as a final output of representation but as a communicative vehicle. The overlapping of the levels of interaction between tools, software and communication languages, from the earliest stages of composition, anticipated the ordinary relationship between machine and man, which places one subordinate to the other. The primary cause of iteration was the generative principle of movement in nature, which recorded in a marine life interval, broken down and sequenced, has become the code of development of the kinematics of animation.
The possibility of having a large amount of data to analyze, has allowed the structuring of a transversal strategy of elaboration of the audiovisual content. For this project we used the principles of computational analysis for clustering data in a three–dimensional environment, taking as input parameters only the position attributes derived from the data extraction process. In this phase we provided the algorithms with a series of data samples chosen from the cluster categories, observed the results by manually correcting the parameters with respect to the expected aesthetic configuration and as consistent as possible with the processes of relation between real and virtual.
The Swarm Intelligence algorithm [Bonabeau, Dorigo, Theraulaz 1999] was used to generate the kinematic flows. Based on the analysis of the mass movement of fish, it is able to simulate the optimization principles of the movements of marine animals within the social behaviors during migration periods, and in strategies aimed at finding food and self–protection.
This algorithm is therefore one of the best approaches for the realization of complex kinematic structures composed of numerous agents, the considerable advantages such as high speed convergence, flexibility, fault tolerance and high accuracy, are essential and unavoidable values for the synthesis of a container capable of metabolizing the enormous amount of data collected during the previous phases.
Touchdesigner [1] was used as the synthesis software for this first test phase of the data integration method to manage the emission and control processes of particle elements in real time. The software manages these entities by means of 'SOPs' (surface operator families) which

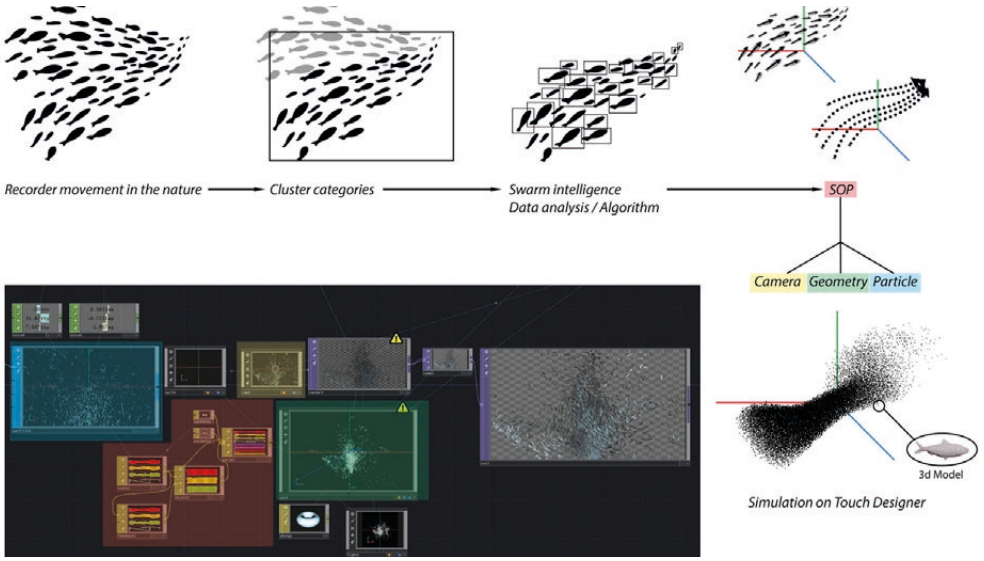

Fig. 2. Software procedures.

guarantee the parametric connection between numerical entities with motion streams. The Surface Operators family, or SOPs, is useful for all 3D operations, whether they refer to simple three–dimensional geometries, particle systems, architectural models, or 3D characters. For the optimization of rendering and thus visualization of real–time graphics processing, it should be remembered that SOP transformations occur on the CPU, which must be performed for each vertex in the geometry, taking up a lot of resources; instead, component–level transformations are applied directly to the 3D geometry, or object, as a whole and are computed on the GPU as a single operation. A single operation performed on the GPU is definitely preferable to what could be hundreds of thousands of operations performed on the CPU. The total number of points, primitives, vertices, and meshes will vary depending on which model is being processed, but the basic principle is that the more polygons/vertices there are, the more computing power and graphics memory will be required to complete the tasks. The project verified the possibility of connecting such SOPs with the Swarm Intelligence algorithm to include in the kinematic generation processes aspects of the natural movement of marine living beings. Connecting the calculation matrices to the SOP operator, the data of interest are segmented to extract numerical parameters inherent to the management of their position, rotation and scale on the three x,y,z axes. These data are linked to the Instance of the geometry containing the 3d source model of the particle system. The geometry instances in the Geometry COMP are copies of the object, which can be transformed independently. In fact, it is possible an instance for each sample of a CHOP, row of a table, pixel of an image or point of a SOP. In this way, each individual particle is a 3d model with its own levels of automatons. In this experimental design phase, the entire particle group is modified in the physical simulation parameters, specifically turbulence and wind,

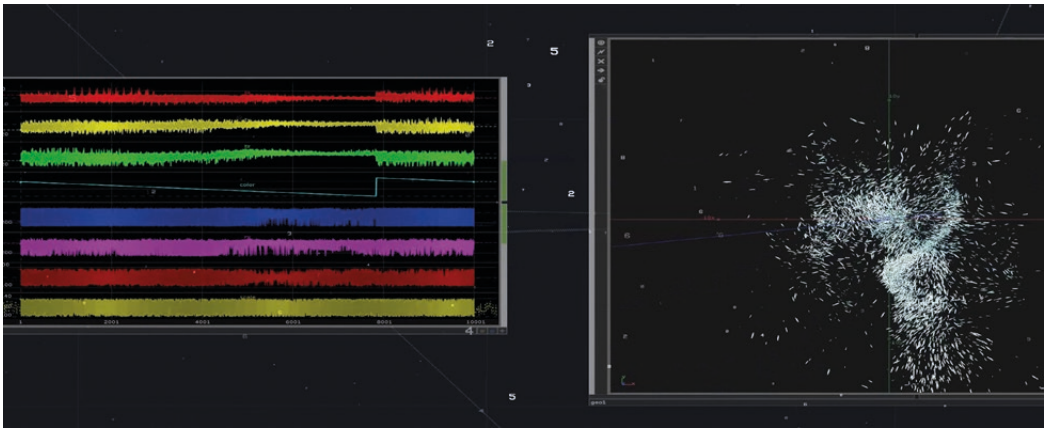

Fig. 3. Video editing phases.

by real–time audio analysis. (fig. 2) The aesthetic result obtained from the verticalization of the swarm intelligence algorithms and the vector fields obtained from the data extraction process is based on a continuous reiteration of the same data, which are influenced again at each frame, generating a swirling kinetic movement; the nodes of which the algorithm is composed generate intelligent feedback signals that mimic the social behavior of marine animals, elevating a behavioral characteristic to an aesthetic parameter.

Results

The 'sea experience' is the paradigmatic object used to build a model of representation of a dynamic reality, such as the underwater one and its fauna, through the application of fluid architectural constructs rendered through the methodologies of generative digital design. The connection of the two realities, the original and the disguised one, has obtained by means of a rigorous process of acquisition of the real data, which underwent a process of data–analysis and data–extraction to be then processed with artificial intelligence algorithms that defined the formal and expressive rules of the virtual artefact.
The analytical model of information extraction took into account the different dimensional metrics typical of a living environment, such as the underwater one, synthesized by means of the three–dimensional vector trajectories made by a school of fish, their speed of movement and the acceleration index in space. The goal was to re–generate a non–mimetic reality of the original by designing a representative complex, with different levels of reading, to stimulate the 'emotional understanding' of the context investigated, in an attempt to bring the level of knowledge to the stage of wisdom (Ackoff's model). The Exhibit design, rendered through video mapping integrated with underwater soundscapes, produced an integration between reality and a narrative component such as to stimulate the imagination, in the sense intended by Bachelard with the term rêverie [Bachelard 1973], and the synchronic perception of the different environmental qualities referable to the places of the sea and the cave.

Notes

[1] The latter is a Python programming environment in which you can visually manage user actors or operators with specific tasks that are linked together to create audiovisual patches.

References

Ackoff Russell Lincoln (1989). From data to wisdom. In *Journal of applied systems analysis*, pp. 3-9.

Bachelard Gaston (1973). *La poetica della rêverie*. Bari: Edizioni Dedalo.

Beni Gerardo, Wang Jing (1993). Swarm Intelligence in Cellular Robotic Systems. In *NATO Advanced Workshop on Robots and Biological Systems*. Heidelberg: Springer, pp. 703-712.

Dede Chris (2009). Immersive Interfaces for Engagement and Learning. In *Science*, 323, pp. 66-69.

Deleuze Gilles (1990). *La piega. Leibniz e il Barocco*. Torino: Giulio Einaudi Editore.

Deleuze Gilles (1997). *Differenza e Ripetizione*. Milano: Raffaello Cortina Editore.

Bonabeau Eric, Dorigo Marco, Theraulaz Guy (1999). *Swarm Intelligence: From Natural to Artificial Systems*. Oxford: Oxford University Press.

Levy Pierre (1997). *Il virtuale*. Milano: Raffaello Cortina Editore.

Maldonado Tomás (1993). *Reale e virtuale*. Milano: Feltrinelli.

Repola Leopoldo (2008). *Architettura e variazione attraverso Gilles Deleuze*. Napoli: Istituto Italiano per gli Studi Filosofici.

Repola Leopoldo (2018). Spazi coesistenti | Coexisting spaces. In Salerno Rossella (ed.). *Drawing as (in) tangible representation.* Milano: Gangemi Editore International, pp.781-788.

Roberto Diodato (2005). *Estetica del virtuale*. Milano: Paravia Bruno Mondadori Editore.

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