Kirini: An Interactive Projection-Mapping Installation for Storytelling about Mediterranean Beekeeping Heritage

Nikolaos Ioakeim, Petros Printezis, Charalampos Skarimpas, Panayiotis Koutsabasis[0000-0003-0478-7456], Spyros Vosinakis[0000-0003-1735-4297] and Modestos Stavrakis[0000-0002-0694-6038]

University of Aegean, Department of Product and System Design Engineering, Syros, 84100, Greece

{dpsd16036, dpsd16095, dpsd16100, kpg, spyrosv, modestos}@aegean.gr

Abstract. Project Kirini is an autonomous interactive indoor exhibit, which utilizes the technologies of projection mapping and physical computing to highlight the cultural heritage of beekeeping in the island region of Cyclades in Greece. The team members researched and collected material on the tradition and the techniques of beekeeping from the ancient times until today through bibliographies and physical interviews. After the completion of the research and organization of the information, the team designed four different types of interactive scenarios. Through a set of formative evaluations, several issues comments and ideas emerged and iteratively implemented to enhance the prototype. Having gathered the results and the conclusions from the evaluations an interactive exhibit was produced and installed in public space.

Keywords: Interactive Exhibit, Storytelling, Projection Mapping, Physical Computing, Beekeeping, Apiculture, Cultural Heritage, Cyclades.

1 Introduction

Project Kirini is an autonomous interactive indoor exhibit, which utilizes the technologies of projection mapping and physical computing to highlight the cultural heritage of beekeeping in the Cycladic islands located at the Aegean Sea in Greece. It is based on beekeeping's history, techniques and practices that have been used in the past and continue to exist in the present, as well as current testimonials. The project idea is presented by an interactive documentary based on a large-scale projection installation with physical interaction. It has an educational and entertaining character. Users have the ability to interact with a room that is fully mapped with projections (walls, floor). The users are involved in various tests / tasks that are presented throughout the scenario. Each task is related to a specific part of the scenario and is dubbed by a voice over narration.

The project belongs to the category of interactive exhibits. It can stand on its own as part of a museum, in an exhibition area related to beekeeping or independent in a suitable room. Depending on the installation space it would require appropriate adjustments in association with the audience and its duration, as well as to the installation itself. In this project we approach Kirini as an autonomous exhibit, intended for ages 12 and above, while its chapters aim to approach all ages.

Today, we experience an increase in interest from the audience for exhibits rich in content, quality and interaction. Interactive systems are the solution as they more easily capture the viewers' interest and expose them directly to information with which they come in physical contact and therefore assimilate them faster and easier. When it comes to exhibits with an extensive narrative character, viewers need even more motivation to stay focused. In such a case, a system rich in audiovisual material and interactions becomes essential [1]. A system with a narrative character can more effectively strike at the emotion of the audience and therefore transmit ideas, information and raise awareness [2]. Research supported by this paper aims at proving the technological means to raise awareness on the importance of bees for the environment, inform users about the value of beekeeping practices as exercised in the past and today and thus promote interest and educate people to understand the necessity of the protection of these cultural assets.

2 Related Work

In recent years technology has allowed us to acquire experiences of cultural content in new and exciting ways. A number of methods, techniques and design approaches where presented in literature to prove this fact [3–10]. In this section we provide a short review of the most important projects, similar to our work. The following projects are independent examples of smart applications of today's technology, for the entertainment of people or even for a new experience of visiting an art museum. Immersive Interactive Ltd. is a system that uses Kinect motion sensing controller, projectors, and projection mapping software to display video and images within a space with which a user can interact. The user can solve quizzes given by the system itself and do various actions by simply waving his/her hands or touching the projection. The big difference with the project Kirini is the technology that is used, the absence of narrative flow in the form of a documentary as well as that the user has to read the system usage instructions. RoomAlive is a concept project that uses projection mapping in a room setting. It achieves it by using projectors and depth sensing cameras, thus turning the room into a projected surface. By simultaneously using projection software, Kinect and motion sensors, users can interact with the space around them by leaning against the walls and the floor. It offers many possibilities for interaction in the form of a virtual game. It has similarities with project Kirini, although it does not entail physical contact with surface areas or tangible objects in the given space. It focuses on providing an entertaining rather than an educational character. Vincent Van Gogh The Experience is a touring exhibit on the works of the famous post-impressionist painter. Using multiple projection mapping technologies, an

entire museum wing (or an exhibition space respectively) including many different rooms, halls and big objects is mapped. On the surfaces, animated versions of the artist's works are projected. This layout makes a lifelike environment and thus immerses the visitors to the content presented. The project is not an interactive installation and therefore it does not provide any means of direct involvement through action to the users.

3 Research, Design and Prototyping

To complete this project we followed an iterative design approach based on the methodology presented in the Interactive Systems Design Studio course [11] and it can be described with the following intertwined phases: Research and inquiry (R&I), Design and prototyping (D&P) and Evaluation and testing (E&T).

3.1 Research

This phase concerned the research that had to be conducted. The stage lasted three to four (3-4) weeks. It was focused on beekeeping's history and techniques in the Mediterranean and Aegean areas from antiquity to the present [12, 13]. At first a quick prepanning of our research took place in identifying potential sources and securing their availability. Some basic information was found on bibliographic sources about beekeeping, honey production, problems that beekeepers were faced through times, historical facts, characters and people's testimonies [14, 15]. This material arranged and our research was planned accordingly. We identified three main areas of interest about the beekeeping practices and history of apiculture: Antiquity, Middle Ages and Present time. Each member of the research team undertook the task of finding further material for each research topic. Materials found in books, as well as information from relevant conferences and living testimonies were used besides the information from the internet. It's important to note that live testimonies from experienced beekeepers were used in this paper / work as non-disputed information. A big part of this data has been used but not to their entire extent.

When all the available material had been collected, the team started filtering the information and organizing the most useful and important parts of it. For antiquity, we used ancient Greek myths about beekeeping that show the importance of the bees and their honey information about the beehive's form and techniques that were used back then to extract the honey from the hives [14]. In the Middle Ages, we paid attention to Cyclades and beekeeping active islands [13, 14]. It mentions each beehive's variation of the form and functionality as well as each beekeepers' techniques. For today, our research was focused mainly on current beekeeping techniques. Important information was gathered through our interview with an experienced Syrian beekeeper and his personal history with the art. Having collected the desired material, the team started creating the structure of the script which would communicate the most important elements of the information to the users in a more understandable and simplistic form.

3.2 Design

The general idea of the exhibit is an interactive room with a control center in the middle. All four (4) walls of the room are video projected with content. The user, by utilizing the controllers from the control center as well as touching the projected walls, can interact with the main scenario and complete specific tasks after following the guidelines provided from the voice-over narration.

This phase included an eight-week-long design phase, including designing the prototype, writing the script, choosing the technologies and developing the audiovisual content. Having completed the research and the organization of information, the design team proceeded to design four different types of interaction with the system, as indication of the system's potential. We ended up with the following four: Games, Trivia questions, Control of narrative's flow and Interaction with tangible objects and the video projection.

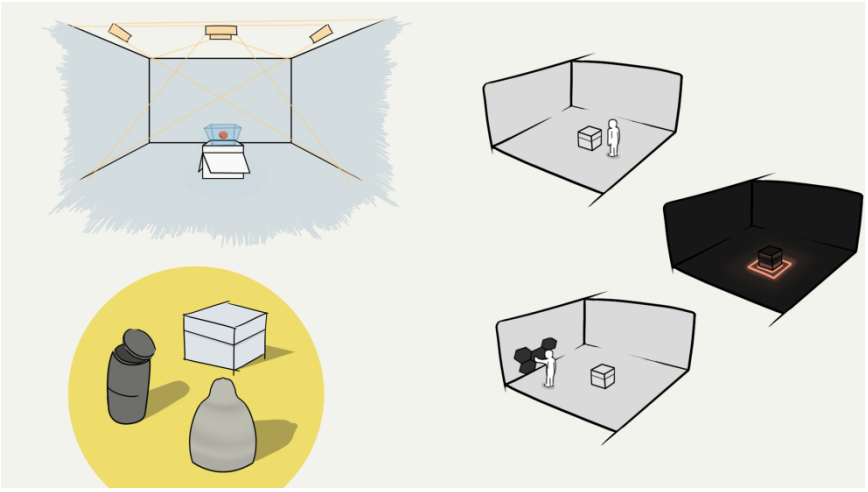

Fig. 1. Concept ideas of the exhibit

The first task regards the chapter of Antiquity, in mythology. It consists of a simple digital obstacle game where the user is asked to control a digital character. As presented in Figure 2, the goal is to avoid the lightnings of Zeus that comes towards him/her, until the designated time passes, and the character is saved.

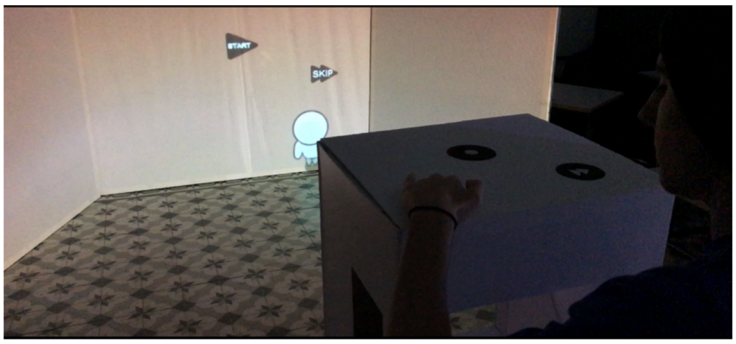

Fig. 2. The first Interaction, Digital Obstacle Game

The second task is also about Antiquity. The user, based on acquired knowledge provided by the installation, is asked to answer a set of multiple-choice questions. The representation of the questionnaire is provided by an ancient honeycomb. The user is asked to pick the right answer by touching one of the four different options (respective honeycomb cell) on the wall.

Fig. 3. Third Interaction, Island Selection

The third task takes place in the chapter of the Middle Ages. The user is asked to interact with a projected map on the wall and pick a Cycladic island for which he/she wants to learn information about its beekeeping history (see Figure 3). The fourth task is about the chapter of the current era and invites the user to select a "honeycomb frame" and place it in the right hive. For this reason, the system provides three (3) tangible objects that represent a honeycomb frame and ask the user to place them in an appropriate socket. Every honeycomb frame prob has unique physical and visual characteristics in order to be distinguishable from the rest (see Figure 4).

Fig. 4. Fourth Interaction, Interaction with tangible objects

After the ideation of these four interactions, we created use case scenarios, the semi-final script of the documentary (with room for small content changes) and some indicative storyboards describing the entrance of the user in the room, his first contact with the system and how it's operation will proceed. At the same time, task analysis diagrams were created and were corrected and made more detailed in the design process that followed.

The control center was the last piece of the Design. It would represent a beehive in shape (and in particular the "warm construction" that was designed by the monk Stephen de la Rocca [12]) and through this the user could interact to some extent with the system. It would include projections in a form of holograms, which would represent the three of our narrators as well as it would show some indications for the user about the operation and interaction with the system.

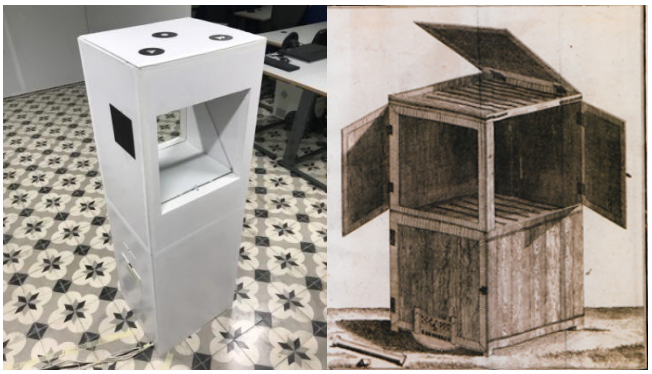

Fig. 5. Left: Our final prototype of the Control Center, Right: De la Roca's "warm construction" [12]

3.3 Prototyping

The technologies tested and used for prototyping include hardware and software platforms. For hardware we used Arduino, Bare Conductive Touch Board and a variety of sensors and actuators. Software used includes Unity, Qlab and MadMapper. Since we

concluded that we could make use of these technologies, we performed technology tests and focused in identifying potential problems and incompatibilities with our scenarios. One useful conclusion that came up was that Arduino Uno did not meet our needs. More specifically, the Midi and Keyboard libraries were not functioning as expected, to trigger events on Qlab. For this reason we chose to continue with two of the Care Conductive Touch Boards which also provided core libraries for Midi and keyboard interaction. In parallel to this design task we completed the script direction and the graphic design and animations of the exhibit using frame by frame technique. The graphics where designed to represent real objects and locations of the Cycladic area, except for the part of Mythology in the chapter of Antiquity that were loosely based on reality and were mostly conceptualized by the graphic artist/animator.

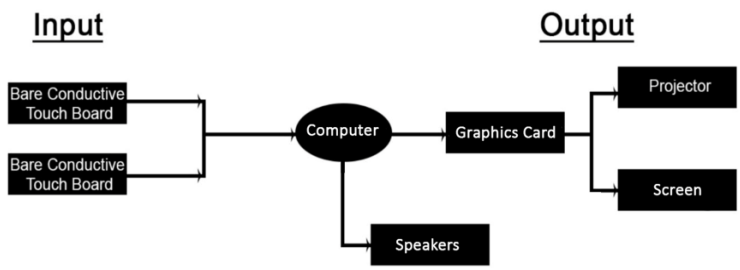

Fig. 6. The structure of the whole system

The first prototype was based on the task of 'island selection' of the third chapter. It consisted of a small-scale model, and the projector. For the control center and its hologram, we built a miniature physical model made from paper and utilized a tablet as a projector of the visuals.

After several design iterations the final prototype was an actual full-scale room. The prototype was built by using three wooden frames covered with cloth for the room walls, the contact points on the fabric were created with copper threads which passed through one side of the cloth to the other where the wiring existed while in the control center the corresponding contact points were created with conductive paint provided by Bare Conductive. In terms of interactivity, these touch points provided the user with a tangible interface to control the Trivia questions, and Control of Narrative's flow. The control center was created with an actual 1:1 scale. On its top surface the physical controls/buttons where placed: one to initiate the application of the exhibit, another to start the game and finally a skip button for advancing to the next task. On the right and left sides respectively the buttons that control the character of the game where placed, while on the lower left side a drawer that contained the three tangible honeycombs of the fourth task where placed. At the center of the construction an opening was created to support the displays of the hologram. All individual pieces of the control center operated through a Bare Conductive Touch Board and

touch interaction based on conductive sensors. A second Touch Board was also used for the cloths covering the walls. These included eight (8) contact points for the island selection and four (4) other points for the multiple choices used on the honeycomb tasks (Trivia question). The video wall projection was developed with a wide-angle projector, mounted on a tripod (stand) at the right side of the room. The following Figure 7 provides a schematic of the various components used and the general layout of the installation.

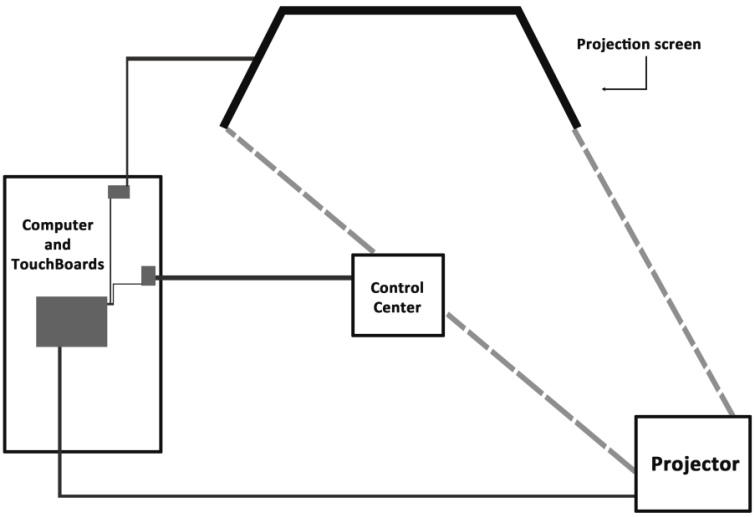

Fig. 7. Room's Layout with components

4 Evaluation

The evaluation took place after the installation of the prototype and it lasted two days. Its purpose was to expose aspects of the system that needed improvements, simulating the experience that a person would have with the final system. The information that we would extract through this process would help us improve the system to a more ideal form, in the evolution of the interactions and in the functionality of the whole structure.

Twelve (n=12) people were divided in six (6) teams of two (2). By design this is considered the ideal number of people for the simultaneous use of the system. The volunteers were university students through the ages of 19 and 23 years of age and professors 35 to 45 years of age. Most of them were not familiar with such systems. Each evaluation lasted about 30 to 40 minutes. Each team was requested before the start of the process to externalize their thoughts, while some important instructions were given to familiarize them with the subject and understand what they were about to experience. The users then came in contact with the system itself. They experienced a complete simulation of the final project/exhibit. During this process the re-

viewers (we) had the role of a passive observer and acted only if user aid was needed. However, every user's move and action was observed and then recorded for later evaluation of the system's use. At the end of the process, the users were given a twenty (20) part questionnaire to answer, with questions relative to the theme, the interactions, the aesthetics of the graphic elements and generally the experience and the construction of the system.

Via the evaluation, many problems and aspects that needed improvement were recorded. Some of the most basic problems and discoveries were: a) that the users didn't know where to stand during the test, b) didn't know when they should leave and/or return at the control center or walk toward the projection surface, c) we found some issues with the clarity of the interactions, d) some of the users said that they would like to see more interactions to feel more engaged throughout the whole experience and e) an issue was discovered about the control center which didn't allow the smooth use of the system for every height (taller users were unable to observe the hologram). From the questions that were made at the end, we could proceed to some quantitative results about which of the three chapters was more favored from the users in terms of content, and which was the most liked interaction.

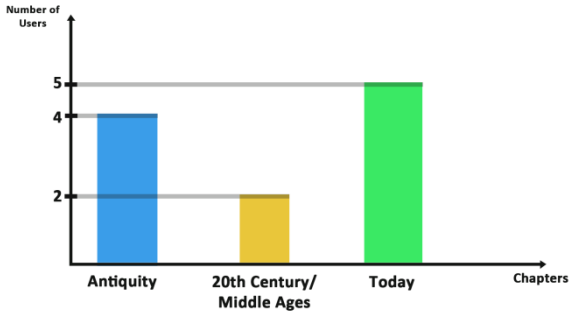

Fig. 8. Diagram showing which Chapter the users preferred most

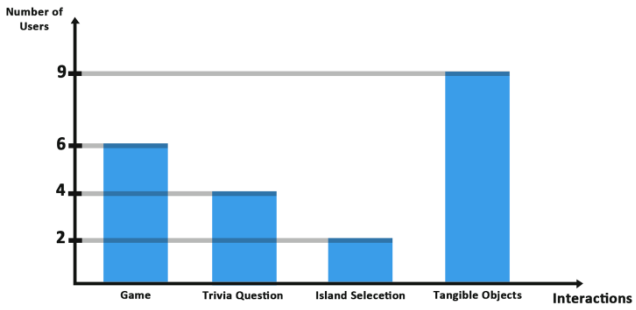

Fig. 9. Diagram showing user's most preferred interaction

All the users expressed learning things about beekeeping after this experience as well as it was made really engaging by presenting information in the form of animation and live narration. One of the things that was requested by users when they were asked "what they would change in this system", was to be able to choose one of the three chapters and the option to repeat the instructions of the interactions again in case they missed some information.

4.1 Evaluation results and future directions

The evaluation of the early prototype led to the collection and modeling of the evaluation data. In the following list we summarize the most important findings:

- Interaction with video projected content in large rooms is a current design trend.
- The system is expensive to implement and needs specialized staff for installation.
- Information overload is not ideal for all users, especially for children.
- The user of hologram narrator and animated projection better engage users.
- Interaction mechanisms capture users' attention but also distract them.
- The design physical components must consider ergonomic factors.
- The animations should be rich and not static to keep the interest of the children.
- Interactions should be explained in detail to be understood by all users.
- Users need time comparative to amount of information in order to grasp data.
- Upon physical interaction, audio feedback is considered important.

5 Summary

Although there were areas for improvement and pieces in the design that we had not calculated from the beginning, we managed to accomplish our main goals, which were raising awareness and informing users about beekeeping culture, while entertaining them throughout the exhibit.

The need for interactive narrative exhibits and its usefulness would be assessed by performing the evaluations in a complete room, in a relevant space such as a museum or an exhibition and with the participation of people who really show interest in learning about the relevant issue. The evaluations would be in the form of a study of use by visitors in the field, as they were performed in our prototype, letting users externalize their thoughts throughout the exhibit, following a series of targeted questions. Our prototype's purpose was the "proof of concept" and that is why the evaluation of these objectives would follow in it's later generations.

Having the results and coming up with our conclusions from the evaluations, we proceeded in the implementation of the final form of the exhibit. Bearing in mind the difficulties the users encountered, we came up with a different design for the control center.

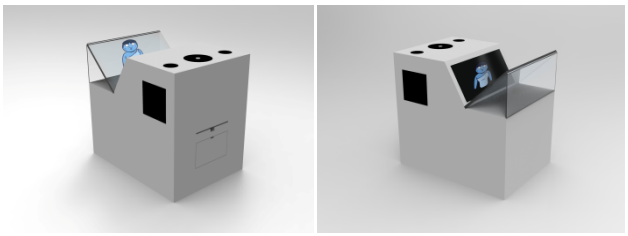

Fig. 10. Renders of the Control Center's final concept

Initially we changed it's form to accommodate more users regardless of their height and position in the room. Then we changed the position of the screen and the glass that reflected the projection from the screen to create the hologram. Now the glass is placed in the front of the structure, while the screen was placed just in front of the glass having a 45 degrees inclination between them. Now, the users can see the hologram clearly by standing in front of the controls (from the reflection of the glass), as well as standing on the opposite side (by looking through the glass to the screen). Also, the drawer that contained the "honeycomb frames" for the fourth interaction was moved to the front part so it could be more easily detectable by the users. Finally, one more projector will be added to achieve projections on the four walls of the room thus having five in total (4 projections for the walls and 1 for the floor).

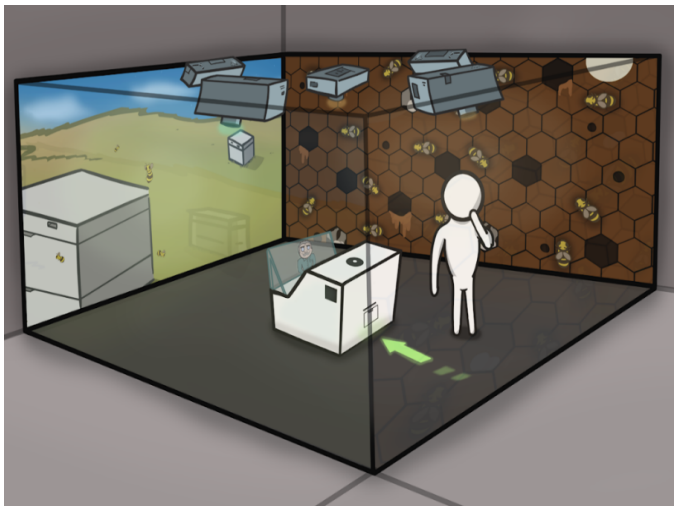

Fig. 11. Final concept of the project Kirini

References

1. Khalaf, M.: Smart cultural heritage: technologies and applications. 10 (6 pp.)-10 (6 pp.) (2019). https://doi.org/10.1049/cp.2019.0183.
2. Beltrán, M.E., Ursa, Y., de los Rios, S., Cabrera-Umpiérrez, M.F., Arredondo, M.T., Páramo, M., Prados, B., Pérez, L.M.: Engaging people with cultural heritage: Users' perspective. In: International Conference on Universal Access in Human-Computer Interaction. pp. 639–649. Springer (2014).
3. Dimitropoulos, A., Dimitropoulos, K., Kyriakou, A., Malevitis, M., Syrris, S., Vaka, S., Koutsabasis, P., Vosinakis, S., Stavrakis, M.: The Loom: Interactive Weaving through a Tangible Installation with Digital Feedback. In: Lecture Notes in Computer Science. Springer, Olimje, Slovenia (2017).
4. Gkiti, C., Varia, E., Zikoudi, C., Kirmanidou, A., Kyriakati, I., Vosinakis, S., Gavalas, D., Stavrakis, M., Koutsabasis, P.: i-Wall: A Low-Cost Interactive Wall for Enhancing Visitor Experience and Promoting Industrial Heritage in Museums. In: Ioannides, M., Fink, E., Brumana, R., Patias, P., Doulamis, A., Martins, J., and Wallace, M. (eds.) Digital Heritage. Progress in Cultural Heritage: Documentation, Preservation, and Protection. pp. 90–100. Springer International Publishing (2018).
5. Ronchi, A.M.: eCulture: Cultural Content in the Digital Age. Springer Science & Business Media (2009).
6. Hu, J., Bartneck, C.: Culture Matters: A Study on Presence in an Interactive Movie. CyberPsychology & Behavior. 11, 529–535 (2008). https://doi.org/10.1089/cpb.2007.0093.
7. Márkus, Z.L., Kaposi, G., Veres, M., Weisz, Z., Szántó, G., Szkaliczki, T., Paneva-Marinova, D., Pavlov, R., Luchev, D., Goynov, M.: Interactive game development to assist cultural heritage. Digital Presentation and Preservation of Cultural and Scientific Heritage. 8, 71–82 (2018).
8. Legrady, G.: Intersecting the Virtual and the Real: Space in Interactive Media Installations. Wide Angle. 21, 105–113 (1999). https://doi.org/10.1353/wan.1999.0005.
9. Saleh, F., Badawi, M.: Cultural interactive panorama (culturama), https://patents.google.com/patent/US20070139626A1/en, (2007).
10. Hagebölling, H., Lling, H.H.: Interactive Dramaturgies: New Approaches in Multimedia Content and Design. Springer Science & Business Media (2004).
11. Koutsabasis, P., Vosinakis, S., Stavrakis, M., Kyriakoulakos, P.: Teaching HCI with a Studio Approach: Lessons Learnt. Presented at the Proceedings of 22nd Pan-Hellenic Conference on Informatics conference (PCI'18) , Athens, Greece (2018).
12. Della Rocca: Traité complet sur les abeilles, avec une méthode nouvelle de les gouverner, telle qu'elle se pratique à Syra, île de l'Archipel; précédé d'un précis historique et économique de cette île. Par M. l'abbé Della Rocca. Chez Bleuet père, Paris, (1790). https://doi.org/10.5962/bhl.title.36423.
13. Hatjina, F., Mavrofridis, G., Jones, R. eds: Beekeeping In The Mediterranean, From Antiquity To The Present. DIVISION of APICULTURE Hellenic Agricultural Organization "DEMETER"-GREECE, Nea Moudania (2017).
14. Hatjina, F., Mavrofridis, G., Jones, R.: Beekeeping In The Mediterranean, From Antiquity To The Present. Bee World. 91, 28–28 (2014). https://doi.org/10.1080/0005772X.2014.11417587.
15. Prost, P.J.-, Medori, P. eds: Apiculture. Intercept Ltd, Andover (1994).