Robots and Cultural Heritage: New Museum Experiences

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Robots and Cultural Heritage: New Museum Experiences

Maria Luca Lupetti, Claudio Gennari & Luca Giulianho

The introduction of new technologies to enhance the visiting museum experience is not a novelty. A large variety of interactive systems are nowadays available, virtual tours, which makes cultural heritage accessible remotely. The theme of access in terms of accessibility and attractiveness has lately been faced with the employment of the service robotics, covering various types of applications. Unfortunately, many of these robotic solutions appear not really successful in terms of usability and usability. On the basis of this awareness, a design for a new robotic solution for cultural heritage has been proposed. The project, developed at the Royal Residences of the Royal Palace of Caserta, consists of a telepresence robot designed as a tool to explore inaccessible areas of the heritage. The employed robot, called Virgil, was expressly designed for the project. The control of the robot is entrusted to the museum guides in order to enhance their work and enrich the cultural storytelling.

1. INTRODUCTION

In the 17th century, the magic lantern technology (a projection system which was the forerunner of the cinema) was used mostly in the earliest forms of museums, the Wunderkammer, to make visits more attractive and engaging.

Nowadays, these centuries later, visitors interact with the museum content via multimedia systems (tactile sensors, virtual reality, etc.) and in a variety of ways (touch, free actions, voice), either on-site or remotely (Lupetti, 2011). The core concept of the project, pursued, is the definition of laws and agreements for cultural heritage, as outlined by the first declaration of the Italian-French Cultural Commission (1967). "The actions of conservation, defense and enhancement of cultural heritage are based on the principles of the social function that is achieved as long as the most extensive public use is guaranteed" (Lupetti, 2011).

An increasing trend in the fruition of museums is, indeed, represented by virtual tours, based on the same concept of wide accessibility. Virtual tours, indeed, aim to make the cultural heritage visible for all. The project, conducted by the museum guides, as study and research, to encourage people to visit the museum and give them a preview of the location. The most popular example is, probably, the “SelfGuided Virtual Tour” offered by Google Art Project (Proctor, 2011), a sort of repository of digitized masterpieces and objects from all over the world. Through the web, people are able to navigate autonomously in a realistic environment that reproduces famous museums and galleries containing 3D modelling and HD pictures. It is also possible to zoom on artworks and observe details undetectable by human eyes. It is possible to recognize different typologies of virtual tour, on the base of the technological orientation, and each one offers a slightly different functionality. The adoption, combined with the effectiveness of the technology adopted, is the result of the consequent adoption of the service (Sarhni et al. 2013). With regard to this, Syllau at al. conducted a Usability Evaluation study (Syllau et al. 2014) of these different typologies evaluating their quality on the base of the indications of the ISO-9241, which relates to the usability and ergonomic requirements of interfaces (ISO 2011). The evaluation is mainly based on five parameters: namely ease of learning, efficiency of use, ease to remember, few errors production and pleasantness of use. From this analysis arises the fact that the effectiveness of a virtual museum is related to its ability to offer the visitors an experience rich in features, but most of all, the accessibility and flexibility, adaptability and entertainment (Syllau et al. 2014). People, indeed, largely appreciate the ability to explore the virtual museum, choosing when and where to deepen, whereas a low quality of the displayed environment leads to the disengagement. The employment of virtual museums, hence, even if it aims to improve accessibility and attraction of the museum, in some cases could lead to the opposite result. As stated by the London Charter, this kind of solutions has to be employed when they can provide added value in comparison with other methods (Beshman et al. 2006).

In this sense, a new frontier is represented by service robotics. Features common to robotics applications, such as the autonomy, bring people in interaction, autonomous movement, people and objects recognition and new ways to face the recurrent themes of Cultural Heritage innovation, while remote exploration, increase of the accessibility, attraction and the improvement of the user experience.

2. METHODOLOGY

This paper, therefore, discusses the remote fruition experiences of museums, with particular reference to service robotics for the development of a new museum experience. In particular, the research concern a project developed at the Royal House of Savoy in Piedmont (Italy).

The first part of the research is dedicated to related work, an overview of international case studies analysis assessed by looking at the quality attained by the design of the service referring to the parameters indicated by the ISO-9241, shown in the introduction. The strengths and weaknesses of the two typologies of virtual tour, on-site and remote, are studied analyzing the degree of empathy created between the visitor and the museum. The museum, indeed, is not only a collection of artworks, but rather a physical and emotional context (Scully 2006) which is fundamental to not lose the perception of details compared to the whole, of the contrast between light and darkness, of the scent of the materials, of the sounds and the silence. For this reason, there has been developed a deep software scenario analysis, in which both physical aspects of the context and human activities have been taken into account. From the scenario analysis, with a special focus on ethical aspects, there have been defined requirements on which have been developed the robotic service concept. The project includes, also, a product design phase, in which the robot Virgil has been designed.

2.1 Related work

The use of robots in museum context is not a novelty indeed there is a large scientific literature about it. Since now, the robots were used mainly in three museums: guide telepresence and installation.

Museum guide: Definitively, the robotic museum guide category is the most common and includes applications from all over the world. These robots are all characterised by the ability of autonomous navigation, obstacle detection and verbal interaction with visitors to describe the contents of the museum.

Already in 1994, at the Carnegie Museum of Natural History in Pittsburgh, has been introduced the use of a robot, namedisha at first and Sage later (Nourbakhsh et al. 1999), to accompany visitors in the Dinosaur Hall and guide them through audiovisual information about it (Willeke et al. 2001), provided to the user as an directional narrative speech (Nourbakhsh et al. 1996). Subsequently, in the same museum, were introduced others robots with the same purpose (Willeke et al. 2001).

In the following year, at the Smithsonian’s National Museum of American History has been introduced the robot Minerva, which gave tours to tens of thousands of visitors (Truax et al. 1999). This robot was equipped with a moving head able to produce facial expressions and communicate its emotional state, defined in accordance with the people’s behaviour. These expressive skills improved the attractiveness of the robot and the effectiveness in the guidance (Truax et al. 1999).

The common and central problem of the effectiveness of speech interaction has been faced in the COCOBOBO project, tested at the Archaeological Museum of Agigato, in Italy. In this case the robot, entrusted to the guide activity, allowed visitors to make questions to the robot in order to improve the adaptation of the speech and the coherence of the answer, the robot cognitive architecture has been provided of a semantic module that filter the information received listening visitors’ questions (Mocanu et al. 2005).

In 2000, a group of three different robots have been introduced at the Museum for Communication, Berlin. These three robots were entrusted of different duties: instruction, information and entertainment. The interactive robot was, indeed, a museum guide that accompanied visitors in the tour giving explanations about the exhibits. It was able to move the head up and down to indicate which object it was referring to and also it was provided of a screen on which it could show additional contents (Schatz et al. 2001).

From the engagement and effectiveness points of view, an interesting step forward is represented by UKA. This guide robot, developed for the exhibition spaces around Spain, was able to show emotional behaviour (Alvarez et al. 2010), in addition to facial expressions, behaviour was adapated on the base of the visitor’s behaviour, in order to modulate the rhythm of its actions. From this information, and consists of three main emotional states: afraid, happy and curious (Alvarez et al. 2010).
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Mauro Lucio Lupetti, Claudio Guarnic & Luca Guerriero

Recently, the world most advanced humanoid robot, Aldebaran, has been tested as museum guide at the Japan's National Museum of Emerging Science and Innovation (Falconer 2013). The basic purpose was the same of previous project, but in this case there was a particular attention to the interaction with group of people. For example, in order to understand who is in front of the public is asking a question, it suggests people to rise a hand before. Unfortunately this feature, such as others, was not working as was supposed to and the overall experience resulted negative from the engagement point of view (Falconer 2013).

Telepresence The category that, probably, is witnessing the wider expansion is the one of telepresence robots. These consist of robots that, connected to the web, allow visitors to explore the museum remotely. In general, these are all mobile robotic platforms equipped with a screen and a camera. The use of this kind of robots is applied with different purposes.

The robot Ceiro, for example, has been introduced at the National Museum of Australia, in order to allow people unable to reach the museum, e.g., students from rural areas of Australia or the aged in nursing homes, to visit it anyway (CSIRO 2015).

The robot Norto, from Droids Company (Droids Company 2015) instead, was designed to allow people with limited mobility, e.g., wheelchair users, to visit a museum, which, otherwise, would result impervious for them. The robot was placed, and is still working, at the National Centre for Monuments, Château d'Orléans, France. At the ground floor of the museum is a cockpit from which, through a computer, the visitor can remotely drive the robot located at the first floor (Dienes 2016). Another interesting example is the Alter Dant project, which involved the Tate Britain, in London (Tate 2016). The concept of the project is to allow people to explore the museum rooms during the night, playing with the sense of prohibition and exploiting the claims that the visitor assumes during the night. During this experience, available for five nights, in August 2014, some people, chosen randomly, have been connected via internet to the four robot placed in the museum and drove them via computer (Tate 2015).

Installation This category is mostly art oriented and the robotic technologies part of it are, generally, embedded in an artistic or educative setup. One example is the ToCAbopen an educative installation that enables, groups of students, to interact from a space observatory in Ireland to a robotic telescope located in San Francisco, California (Hogan et al. 2015). The installation comprises tangible interfaces and digital displays. The artist-scientist Patrick Tresset, instead, developed a robot art installation called Paul. This installation, exhibited at Tenderpixel Gallery in London for the first time, in 2011, consists of a left hand robotic arm holding a black tie and a pass-slit camera, both behind a table in front of which is located a chair for visitors (Tresset et al. 2012).

These three types of museum robotic applications have been empirically evaluated on the base of the parameters indicated by the ISO-1224 (ISO 2011), shown in the introduction. Specifically, these parameters are meant to evaluate the quality of the interaction.

The interaction with guide robots, indeed, appears easy to learn and to remember, due to the fact that it is based on natural interaction modalities, such as speech, facial expressions, gestures and proxemics. On the other hand, this kind of solutions frequently produces errors (Falconer 2013), which, in addition to the low scalability of the tour, causes a problem of its use and, consequently, risk much pleasantness to use.

Telepresence robot, instead, achieve an higher level of use efficiency and the interaction is easy both to learn and remember, due to the fact that adopt a mediating interface familiar to the users.

The robot control, as a matter of fact, occurs through a computer or a tablet, and the control consists of teleoperation, ability that most of people have experienced at least in childhood. These aspects, thus, determine a higher level of use pleasantness.

Regarding the robotic installations category, it is not possible to make absolute considerations. Nevertheless, it is possible to assume that the easiness of use and remembrance are common as well as the pleasantness. The error production and the efficiency, instead, are the most variable aspects from project to project.

From these considerations emerges the fact that, in most of cases, the robotics is employed in museums regardless the evaluation of the physical aspects of the context and the human activities which are carried out there.

2. VIRGIL: NEW ROBOTIC MUSEUM EXPERIENCE

Virgil (Germain 2015) is a telepresence robot, result of a project for the enhancement of Cultural Heritage and improvement of the fruition experience. This project has been developed for a specific museum context: the royal residence of Racconigi Castle, in Piedmont, Italy. This castle, called over time as "virti di delizia", was a holiday residence of the Savoy royal family. This residence is a surprising rich context (artworks, furniture, everyday objects, clothing, working machinery etc.) but, simultaneously, extremely delicate. All the Cultural Heritage, indeed, are placed to which are entrusted two main activities: the preservation and fruition (Bartoletti et al. 2012). Regrettably, in some cases these two actions are incompatible. For this reason, at Racconigi, some rooms of the residence are currently excluded from the visit tour, mainly because of the state of conservation, fragility and logistic management of the visit. It has been estimated, indeed, that more than 60% of the residence remains inaccessible to visitors during a standard guided tour.

This phenomenon, in which part of the cultural heritage remains hidden, does not only concern the Racconigi Castle, but it is diffused throughout Italy. However, in most of cases the main concern relates to the fact that a large amount of artworks and artifacts remains closed in the archives, whereas the problem of areas excluded from the tour route is not widely addressed.

For example, many newspapers and journals highlight this issue of hidden artworks that would represent an asset to be exploited (Pirelli 2012). This kind of statements are confirmed by the Istituto Nazionale di Statistica (Istat) in the report (Istat 2013) that shows that 31.5% of museums expose just around the 50% of the owned goods (Istat 2013).

The delicate nature of the castle influences, further, the visitor tour. The access of visitors, indeed, is organized in groups of maximum 20 people, mandatorily accompanied by a museum guide or a castle guardian. Therefore, the museum guide assume a central role in the experience of museum visit and, as is well known, their competences have
a strong influence on visitor satisfaction (Mcc Donnell 2001). The storytelling activity performed by the museum guide, thus, comprises three main aspects: selection, information and interpretation. The last one is the aspect that mostly determines the uniqueness of the experience due to the fact that the museum guide uses the interpretation to create an link between the heritage contents and the visitor culture. An effectively interpretative approach, indeed, is what determines the transference of cultural understanding (Mcc Donnell 2001).

From these considerations, therefore, emerge two requirements: make accessible to visitors areas of the residence excluded from the tour and enhance the activity of the museum guides. The proposed service meets these requirements, extending the museum guide also through a immersive virtual tour, made possible by the Virgil robot placed in inaccessible areas. The museum guide assumes a fundamental role since, in addition to the usual accompanying and deepening role in the fruition of the cultural heritage, he is entrusted of the remote control of the robot.

The new robotic service introduces the concept of human-robot collaboration (Epstein 2015). Conversely to many robotic solution applied in museums, as shown in the related work paragraph, the storytelling activity continues to be entrusted to the museum guide and a robot assumes a role of remote collaborator, which explores the areas inaccessible for people. Keep the storytelling activity performed by the museum guide is fundamental due to the fact that only a human can provide the interpretative aspect. The interpretation (Mcc Donnell 2001), as previously explained, is the process in which the museum guide can create links between the visitor culture and the heritage contents. This process allows visitors to develop an empathetic relationship with both the museum guide and the cultural heritage itself.

A further consideration has been addressed in the comparison of this robotic service with other existing technologies, especially virtual tours. As a matter of fact, virtual tours currently seem to be the cheapest and easiest technology available, however involves considerable limitations in terms of immersivity and narration. Even if this solution can achieve high level of image quality, the visual result is never realistic due to the fact that navigating through these environments, the adaptability of the image and the fluidity of movement are not like the natural. In addition, the narrative activity, if entrusted only to multimedia contents, can appear boring, not really adaptable and restricted.

3.1 Robot Design

The robot, designed specifically for the project, consists in a mobile robotic platform, equipped with a camera that sends a streaming video displayed to visitors on a dedicated screen or on personal devices.

The design process was based on specific requirements, namely the robot should be unobtrusive and homogenieus to the context in which is going to be inserted. This is due to the fact that it is necessary to ensure maximum visibility to the art pieces exhibited in the heritage. For this reason, the cover of the robot is made of PMMA (poly-methyl-methacrylate) and is composed in a shape of truncated pyramid, reminding to the similar shape largely diffused in Savoy tradition, used in castles, towers and other architectural elements or furniture. The choice of a transparent material, thus, was lead by willingness to avoid the distraction of the visitors from the cultural goods to the robot and besides to meet a technical requirement of maximum lightness.

This solution, therefore, provides a substantial physical and visual lightness, also in line with the way-finding elements already present in the royal residence. In addition, in the design process has been introduced the concept of customisation based on the context, consisting in a decorative pattern applied on the robot covering. The pattern represents the Palatine palm, an already existing decorative motif that can be found in the castle, applied in many elements, from the floors to the furniture.

3.2 Ethics

From the beginning, this project was developed considering ethic aspects as mandatory. Each design choice was made, not just on the base of technical feasibility, but rather with the evaluation of the alternatives answering to questions such as: is it effective to introduce the robot in this way? Is it preferable the use of the robot compared to other technologies? Is the use of a robot fair towards the various stakeholders?

According to this approach, the ethical dimension of project is achieved in the attempt to ensure respect both for the location and the various stakeholders.

From the location point of view, the service proposes a possible solution to the issue of inaccessibility of some castle's areas. The concept of wider the accessibility meets the statements of the European Community according to which the social fruition of cultural heritage have to be guaranteed for the widest possible audience (Epstein 2011). This is also confirmed by the Decree Law no. 112, which states that a Cultural Heritage have to guarantee the full accessibility, physical and visual, of the buildings, also ensuring the constitution of goods excluded from the exhibition (D. M. 2001).

The service makes possible the exploration of additional areas of the castle even if it is not currently possible to conduct restoration and safeguarding works. In addition, the proposed solution does not require a fixed implantation to perform the activity. Both the robot and the docking station are movable and this meets the requirement to not overbuild in the context, which is a building structured and evoluted over the centuries and, hence, can’t be remodelled by structural interventions (D. M. 2001).

From the stakeholder’s point of view, the project brings benefits to all the actors involved. The visitors, indeed, benefit from the expanded visiting experience, enriched by the additional knowledge about the robotic solution.

The museum guide, instead, assume a central role in the visiting experience, due to the fact that are entrusted of both the cultural storytelling and the robot control. This generates an enhancement of human work and additional professionalisation. This aspect is particularly crucial since it relates to a widely diffused concern about the introduction of robots. The diffusion of robots in industrial field, indeed, generated a substantial replacement of human work and, consequently, an increase of unemployment (Sakurai et al. 2010). The introduction of robotics in other fields rises the concern that the same phenomenon could occur. For this reason, during the design process it is necessary to consider the human work, avoid its replacement and, moreover, enhance it (Blond et al. 2014).

Finally, the institutions, to which is entrusted the Cultural Heritage management, benefits from the improvement of visibility and attractiveness.

4. FUTURE WORK

In the following months, there will be the first experimental phase with visitors, in which the early data on the experience by the users will be collected. For this phase, the museum guide will be first trained to drive the robot. This action does not assert easy at first due to the fact that, in the meantime, the guide has to carry on the usual activity of explanation about the museum contents, which includes also a direct interaction with visitors.
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For this reason, a more intuitive and usable GUI will also be developed. Subsequently, the user experience will be improved, introducing gamification elements to reach a higher level of engagement and cultural contents enhancement.

5. CONCLUSION

The improvement of Cultural Heritage fruition is a recurrent theme and has been faced with the application of the most diverse technologies. The exemplary case represented by virtual tours, which offers the opportunity of a remote visiting experience, enabled a wide range of new design opportunities. Nevertheless, the limits of this kind of solutions drive to a deep reflection on the effectiveness of a totally virtual experience.

For this reason, the use of Service Robotics in museums is becoming increasingly common. Robots, indeed, represent a bridge between the virtual and the physical world, due to their composite nature. However, the observation of international case studies of museum robotics shows that, since now, many of the proposed solutions were not actually meeting the location and stakeholders’ requirements, which usually vary on the basis of the context.

Based on this consideration, a new robotic museum experience has been designed, with the aim to increase the museum’s attractiveness, offer a more involving experience to the visitors, and enhance museum guides activities. The proposed solution was developed paying particular attention to the ethical aspects and is meant to represent a shifting in the robotic design process. The applications of new robotic solutions, instead, are usually based on the opportunities offered by the technology, whereas this project was developed applying a human centered design approach, which focus on people instead of technology.

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7. REFERENCES


EVA LONDON 2015
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The Electronic Visualisation and the Arts London 2015 conference (EVA London 2015) is co-sponsored by the Computer Arts Society (CAS) and BCS, the Chartered Institute for IT, of which the CAS is a specialist group. Over the last two decades, the EVA conference has established itself as one of London's most innovative and interdisciplinary conferences in the field of digital visualisation. The papers in this volume touch on music, performance, arts, visualisation, interdisciplinarity, animation, cultural heritage, 3D scanning, imaging, virtual tours, virtual heritage, museums, as well as other interdisciplinary areas. The latest research by established scholars, early career researchers, practitioners, and students, can be found here.

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