Augmented and personalized digital narratives for Cultural Heritage under a tangible interface

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Abstract

Digital storytelling is widely used to enhance the process of integrating images, music, narrative and voice along with traditional storytelling methods. In recent years, newer visualization technologies such as Augmented and Virtual Reality allow more vivid representations and further influence the way museums present their cultural heritage through interactive narratives. Nowadays, many cultural institutions aim towards integrating such technologies to provide a more engaging experience, which is also tailored to the user by exploiting personalization and context awareness. In this work, the authors present the CHATS platform, a system for personalized digital storytelling in cultural heritage sites, enhanced with state-of-the-art visualization techniques. Technologies of AR and Smart Glasses are used to enhance visitors' experience, while also context-aware and personalization methods are used to provide cultural information based on user's profiles and interests.

Keywords: Digital Storytelling, narratives, tangible Cultural Heritage, context aware, personalization, augmented reality

1   Introduction

Digital storytelling is a widely used method for people all over the world to engage emotionally, communicate and project elements from their culture and personality, and share them with their companions. Humans can really benefit from their own stories, mentally and emotionally, and after all these years, they still learn and improve on telling stories (Kasunic An. et al., 2018). Narratologists agree that to constitute a narrative, a text must tell a story, exist in a world, be situated in time, include intelligent agents, and have some form of a causal chain of events, while also it usually seeks to convey something meaningful to an audience (Ryan et al., 2015).

Not only humans but also cultural institutions can be considered as "natural storytellers" (Bedford, 2001). In recent years, museums aim at making their exhibits more appealing and engaging to an increasing variety of audiences while also nurturing their role in conservation, interpretation, education, and outreach (Roussou M. et al., 2015). The utilization of multimodal storytelling mechanisms, in which digital information is presented through multiple communication ways/media (multimedia) is considered as a supplement to physical/traditional heritage preservation, activating users' involvement/collaboration in integrated digital environments (Psomadaki et al., 2019).

Digital Storytelling derives its engaging power by integrating images, music, narrative and voice together, thereby giving deep dimension and vivid colour to characters, situations, experiences, and insights (Abas and Zaman, 2010). Therefore, modern technologies such as Augmented Reality (AR) and Virtual Reality (VR) can influence the way museums to present their narratives and display their cultural heritage information to their visitors. AR can be seen as a form of mediation using interaction and customization that supports a form of narratives, where visitors can engage or even create their own narrative scenarios in their cultural tour.

Furthermore, personalized CH applications require the system to collect user data while also considering the environmental current parameters, and then process them in order to tailor the user experience. Context-awareness methods can address this requirement, by enhancing the interaction between humans and machines and adding perception of the environment, which eventually leads to intelligence (Abowd et al, 1999). The context in the

cultural space domain can include many features such as location, profiles, user movement and behaviour and environmental data (Not & Petrelli, 2018).

This paper presents the CHATS (Cultural Heritage Augmented and Tangible Storytelling) project, a platform that combines Augmented Reality and Tangible Interactive Narratives. The project analysed here is based on a famous painting named "Children's Concert", by G. Jacovides, and on a previous project in which 3D models representing the painting's characters and objects were created (Trichopoulos et al., 2018). CHATS project aims to contribute to the tangible IN field, which still presents a potential for cultural heritage and other applications. It is a hybrid architecture that combines state-of-the-art technologies along with tangible artefacts and shows usability and expandability to other areas and applications, at a relatively low cost.

2 Related work

A tangible Narrative is a special form of interactive and digital storytelling technique using tangible objects to augment the experience and impart meaning in the field of cultural heritage. Ubiquitous computing poses an opportunity for interactive storytelling. By connecting with tangibles instead of just a visual interface, the audience reacts stronger emotionally to the story. There have been various applications applying tangible storytelling techniques, almost exclusively addressing the problem of presenting appropriate storytelling content to each user. For example, the "Stolen Painting" (Konstantakis, 2019) and the EMOTIVE project (Katifori, 2018) engage visitors, trigger their emotions, connect them to other people around the world, and enhance their understanding, imagination and, ultimately, their experience of cultural sites and content in creating narratives and experiences which draw on the power of 'emotive storytelling', both on-site and virtually. Also, "Sail with Columbus" is an interactive and tangible storytelling project designed for a Nautical Museum. Its goal is to communicate to the museum visitors how medieval men sailed in the past (Ciotoli, 2021). Lilja (2014) focuses on how a single installation can enhance the personalization of the information in cultural heritage museums and enhance the overall experience using interactive digital storytelling and the ability to touch artefacts. Interaction design methods helped establish best practices centring on usability. Furthermore, meSch project[1], has the goal of designing, developing, and deploying tools for the creation of tangible interactive experiences that connect the physical dimension of museums and exhibitions with relevant digital cross-media information in novel ways (Not & Petrelli, 2018).

3 CHATS - Cultural Heritage Augmented and Tangible Storytelling

The Cultural Heritage Augmented and Tangible Storytelling (CHATS) platform includes, as main points of interaction, tangible objects which represent exhibits of a cultural collection. 3D printing can be exploited to produce copies of sufficient fidelity. The platform can be installed in GLAMs which include paintings, artworks, books, and museum artefacts in their exhibitions. The complete architecture of CHATS is illustrated in Figure 1. At the core of the CHATS architecture lies the sensory network, which, following the IoT paradigm, allows smart interaction between users and the system. The type and number of sensors comprising the network depend on the requirements of each scenario and the desired level of interaction, such as the sensitivity, accuracy, and detail of interactive activities. The server collecting the sensory data may be local or exploiting cloud technology. The most typical use of sensors includes the identification of proximity and other interactions such as touching objects, moving hands around objects, causing sounds etc. Apart from sensing devices, the sensory network also includes actuators which manifest the platform's reaction, such as playing sounds or projecting images. Such events are usually triggered by user actions or context-aware procedures.

The visitors begin their interaction with CHATS as soon as they enter the area, with the help of sensors that capture user proximity via BLE technology. This is achieved by providing a BLE tag to each visitor at the time of entry in the cultural site. A BLE transceiver, hidden in a construction that supports the interaction, is automatically paired with the tag and correlates movement with the user. The localization process described above is performed

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[1] https://www.mesch-project.eu/about/

in the Localization module, which is responsible to acquire the localization data from the BLE infrastructure and the behavioural data that capture user activity. The localization information is shared with the Digital Storytelling module, in order to trigger the appropriate actions.

The procedures related to interaction with artefacts are primarily tackled by Arduino controllers, which are embedded in the construction of the artefact. Sensors integrated in the Arduino controller, such as motion detectors, stream their data continuously to the server. Data useful for the user interaction are kept, while redundant data are discarded. The combination of localization and behaviour data along with personalization and other profiled data allowed the dynamic selection of the story trajectory that best suits the scenario.
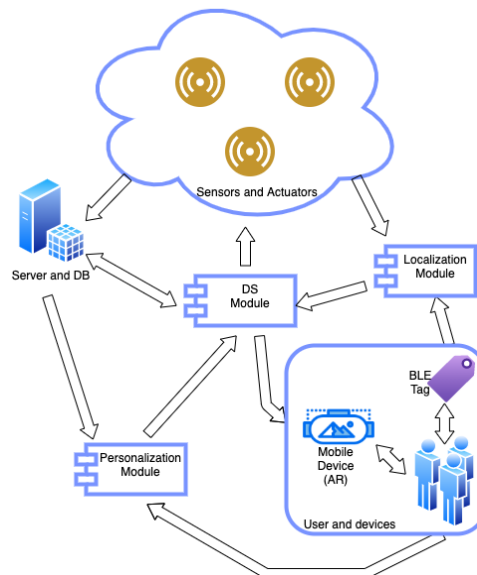

Figure 1. CHATS architecture

Personalization is performed by the equivalent module, which is responsible for executing the appropriate procedures, which include the acquisition of profiled data either stored in the database or directly from the user. The persona of the user is identified and associated with a profile that is relevant to the application at hand. The Personalization module outputs the result of the process to the Digital Storytelling module in order to provide a more engaging and personalized user experience.

Finally, the Digital Storytelling module, residing at the centre of the CHATS architecture, receives the output from all the other modules, analyses the incoming information and delivers appropriate content to the user. Typically, a mobile device is exploited to output the content from the Digital Storytelling module, but CHATS may also be applied to less traditional devices. Smart glasses offer exciting ways to deliver content, exploiting the Augmented Reality (AR) technology. AR content combined with binaural audio for narratives enhances the visitor's experience.

4 Case Study

To test CHATS, a famous painting, found in the Greek National Gallery in Athens, was chosen. This painting, entitled "Children's concert" by George Jacovides, depicts a scene in which some children are playing music for an infant and its mother. There is a humorous feeling in the painting as one of the children is blowing air into a watering can. 3D representation of the painting was already made in a previous project called ARTISTS (Trichopoulos et al., 2018) and the characters involved were 3D printed and used to construct a scale model. Detail and accuracy of the printed characters were never a scope of the project, as all the process of 3D modelling and printing was done for experimenting.

The final constructed diorama works as a user interface, offering multiple interactions. It can sense the presence and proximity of multiple people carrying a tag and users can touch it, put their hands on it and play as the interactions and movements trigger sounds - a narrative.

Standard PLA material was used for printing the characters and other objects (table, chair), and Arduino sensors were put inside (where possible) or on the models. Arduino was chosen as a popular, inexpensive, and versatile platform and the sensors used were ultrasonic distance sensor, capacitive touch sensor, and Bluetooth BLE beacons. The chosen Arduino controller was the Mega 2560, one of the most used Arduino boards.

Everything was placed and glued on a wooden surface, in a way that the painting is being represented as accurately as possible. The whole diorama space is divided into two areas, A and B according to the two ultrasonic sensors located there, and when users enter these areas or touch one of the models, new interactions occur that change the flow of the narrative. The character hosting the touch sensor is the one that is positioned at the closest position to the visitors, while another character hosts the Bluetooth receiver.

The actual interaction with the painting's tangible representation occurs involuntarily before users touch or even approach the models. Visitors are expected to carry a BLE tag and pairing with the Bluetooth sensor happens automatically at a distance within the technical specifications of BLE. This initial pairing triggers the first audio message from the painting, which welcomes and attracts visitors.

At the second level of interactivity, users can enter by hand into the area around the models or touch them. These interactions trigger short narratives about the painting, in the form of sound. These narratives are based on historic facts but are also enriched with fictional features. If a whole group of people (more than one) is nearby and interacting with the diorama, narratives change accordingly.

Augmented Reality (AR) techniques are utilized to digitally visualize data from the narratives. Technologies of AR smart glasses in combination with binaural audio recordings were chosen for an immersive and engaging user experience, combining digital storytelling in 3D virtual immersive learning environments (Mystakidis and Berki, 2018). Data from sensors during user's interactions dynamically change the visual and audio information available through the smart glasses, while also improving the physical interaction with the system.

5 Conclusion

This research work proposes CHATS architecture for personalized digital storytelling techniques on tangible objects. CHATS combines storytelling techniques such as narratives, augmented reality visualization and binaural audio in a dynamic environment that augments cultural user experience. Shaping personalization in a digital storytelling scenario of tangible interaction for cultural heritage involves challenges that go well beyond the requirements of implementing content personalization. Content is coupled with the physical experience of the objects, the space, and the facets of the context acquire a more prominent role.

The proposed architecture was assessed in a use case including 3D printed objects that represented figures of a George Jacovides painting, named "Children's concert". The tangible reproduction of painted characters allowed a realistic representation of the scene described in the painting, providing new and stimulating implementations of digital storytelling consociated with the scene.

Future work will be the evaluation and revalidation of the CHATS project in order to invest effort in providing different users with the right information at the right time and with the most effective type of interaction. We believe that the direct involvement of cultural heritage professionals in the co-design of CHATS technology, as well as the extensive evaluation with users in field studies, will be instrumental in shaping a holistic approach to personalization that exploits in full the new opportunities offered by the tangible digital storytelling interaction.

Acknowledgements

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