

The Human Computer Interaction and Virtual Reality Lab (University of Peloponnese): overview and current challenges

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HCI-VR lab in Short. The Human-Computer Interaction and Virtual Reality Lab, at the Department of Informatics and Telecommunications of the University of Peloponnese, aims to conduct high quality research in areas related to the analysis, design, development, and evaluation of HCI and VR systems and applications, and in parallel to support the teaching requirements of the department in the respective field. Over the last years the HCI-VR lab particularly focuses on Cultural Heritage and develops technologies primarily for spaces of cultural heritage that cover the diverse needs of heterogeneous audiences providing holistic visitor experience. The HCI-VR lab is actively participating in National and European projects on Cultural Heritage, such as FP7 Experimedia (<https://hci-vr.dit.uop.gr/experimedia>), H2020 CrossCult (www.crosscult.eu) and multiple projects from the National Strategic Reference Framework.

1 Overview of activities

Deriving from a truly interdisciplinary background, the HCI-VR lab and its collaborators cover multiple scientific fields necessary for the development of cultural technologies, including computer science, education, psychology (especially cognitive, personality and social), history, archaeology, design (graphics and interface). In this light, the lab researchers have a significant experience in working in interdisciplinary teams and working harmoniously with people of different scientific domains and practitioners. In addition, the HCI-VR lab has developed technologies for real world needs, like technologies for educational purposes and for use in cultural heritage institutions.

The HCI-VR lab has the latest technological equipment required for its purposes, like 3D scanners, 3D projectors and screens, data gloves, VR glasses and headsets, sensors for collection of physiological data (e.g. arduinos) and brainwave devices for mobile EEGs. Its state of the art equipment makes the lab one of the best equipped in Greece. Regarding the lab's teaching activities, the undergraduate and postgraduate students of the HCI-VR lab develop tools and applications for cultural heritage, including games (fig 1), virtual museums (fig 2) and site reconstructions (fig 3). The HCI-VR lab also provides its specialized teaching and learning material, e.g. [1].



Fig. 1. Screen shots from games developed by undergraduate students with mythological themes.



Fig. 2. Virtual museum of the University of Athens Historical Museum created by an undergraduate student.

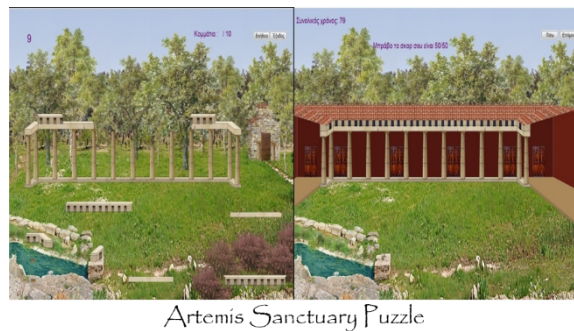


Fig. 3. Ancient sanctuary reconstruction created by undergraduate students.

The HCI-VR lab is also engaged in a strong educational research, including alternative teaching methods [2], since learning is a big part of the quality of experience in cultural settings. Our educational research includes personality characteristics of

learners [3], learning analytics [4], educational robotics [5, 6], social media for educational purposes [7], as well as educational games [8, 9].

Innovative technologies are also investigated like Internet of Things for Cultural Heritage [10, 11], new city guide applications [12] and profiling through social media, as an indirect way to overcome the cold start problem in museum personalization [13]. Virtual reality applications are tested in an attempt to unify visitor experiences and effectively combine sound and vision [14]. New approaches in Augmented Reality have been also proposed and tested, like the novel concept of micro-augmentations which provide minimum stimulation to visitors for maximum effects [15] and cardboard solutions for cost-effective applications [16]. Our novel solutions are tested with real users with various methods, including questionnaires and self-reports, analysis of objective data (e.g. response times, number of errors etc.) as well as collection of physiological data with the help of skin response sensors and brainwave devices.

All the aforementioned activities are supported by the lab's strong expertise on systems design and software engineering, to provide robust, extensible and scalable deployments.

Games are a big part of the lab's research since they are viewed as important tools for cultural heritage [17, 18] supporting both (a) the creation of visitor profiles and (b) learning. The HCI-VR lab has extensive experience in the field of game based profiling for cultural heritage [19-21].



Fig. 4. Examples from profiling games.

The profiling games developed at the lab target at the elicitation of users/visitors' cognitive and emotional profiles and the identification of visitor interests. Apart from profiling tools (e.g. Fig 4), games are also developed to function as dissemination tools (pico games, e.g. Fig 5) and experience enhancers (before, during and after the visit). Furthermore, alternative input methods in games are tried and tested including whole body interaction (Fig 5) [22, 23].



Fig. 5. Example of a pico-game.

In addition, lab staff also investigates different interfaces for use in cultural heritage which support navigation, visitor mobility (Fig 6) and even visitor communication. Trying to avoid the isolation that could result from the use of technological application in venues, collaborative interfaces are also investigated to allow cooperation and communication of visitors [24].

Cultural data semantics and ontologies are a part of the lab's research activity [25, 26]. These ontologies are also enriched with information not only regarding the objects and the venues but also their visitors, establishing couplings between visitors and venues, collections or exhibits. Subsequently, these couplings are used to identify linkages between specific characteristics in the visitor profiles and respective attributes of the venues, collections or exhibits. Personality psychology is applied for personalization purposes and the creation of visitor profiles [27, 28], social psychology is used for the creation of ultimate social experiences [29] and cognitive psychology is used for understanding human cognitive needs and applying technology accordingly [30].



Fig.6. Visitors with mobile applications at the Archaeological Museum of Tripolis.

Finally, at the HCI-VR lab we recognize the need for new methods for collection and analysis of visitor data (e.g. from social media and dedicated qualitative and quantitative methods for the analysis), for the elicitation of user requirements involving different types of visitors like children [31] and for the engagement of visitors. Visitor engagement can be achieved with the use of social media [11, 32] that can easily spread cultural information including virtual museums and online exhibitions [17]. Dedicated visitor specific routes [33] as well as specially designed narratives [34] can intrigue the visitor and increase her engagement. Similar effects can be achieved when venue objects are connected to other digital cultural objects [35] and content like dates important to people [36].

2 Lessons Learnt

Since cultural heritage technologies is by nature an interdisciplinary field, an experienced interdisciplinary team is indispensable for performing successful research in relevant areas. Humanities experts often report problems in understanding Technology experts (and vice versa). It takes an experienced team to know how to elicit requirements and proceed with technology and experience design.

The strict rules that often apply in cultural heritage institutions like archaeological museum require flexibility and willingness to adapt to different frameworks. Technological solutions need to respect the venue limitations and propose alternatives.

Furthermore, very different sites are characterized as cultural spaces including museums as different as archaeological ones and zoos, as well as outdoors spaces like sites and even whole cities. Therefore, one-fit-all solutions do not apply in cultural heritage. There are also important venue characteristics like size, popularity and exhibition theme that seem to require different technological solutions. For example, visitors of museums of different types request different solutions [37].

In addition, user testing needs to follow unobtrusive methodologies that do not disturb the smooth functioning of the venues. In this light, new methods are needed in order to capture the user experience in a cost-effective, non-intrusive, engaging and meaningful manner. Visitor experience is not limited within the actual visit but it is extended before and after it. Social media can be a valuable tool in engaging the visitor before and after (sometimes also during) her experience. Social media can also offer easy ways to collect important data like feedback for curators and technology developers, as well as means to further promote cultural heritage to the wider public and allow visitor communication.

3 Open challenges

The lab staff is currently working within the educational field. In particular, educational technologies (e.g. educational robotics) and alternative teaching methods are investigated. The main challenge here is not simply to see the functionality and the possible effectiveness of the different technologies and practices but also to face organizational issues allowed or not the adoption of such new methods and tools. The lab follows a methodology developed by its researchers for the holistic development and testing of educational technologies and alternative methods, also considering students' and teachers' attitudes and the overall organizational resistance.

In addition, profiling is a main area of research and together with the personality profilers we now also focus on emotional profilers that aim at identifying situation dependent and independent user emotions. To do so, specific games are designed and tested.

Furthermore, being at the core of our activities, games are developed for different purposes like profiling, advertisement but also for the evaluation of the user experience. This last target is very challenging since different evaluation metrics need to be considered.

Another important issue is the rapidly developing field of the IoT that the lab aims at creating new methods for Cultural Heritage and a new paradigm to support the creation of exhibitions and museum narratives.

Moving towards Augmented Reality, the lab focuses on the effects of minimum exposure to stimuli, which is to the best of the authors' knowledge, a very novel approach. The intrusive character of AR applications at the moment makes the study extra challenging, since it is still difficult to apply in real word settings.

Finally, we continue to investigate the role of social media and the possible exploitation in cultural heritage and education, as well as the social dynamics that develop among their users.

4 Tools

Inssofar, the lab has created a number of open source tools in the context of the aforementioned activities, including the following:

- Profilers, like image-based ones and game-based others, to extract various properties of the users' profiles. Users can shortly engage with these profilers (either play mini games or choose a set of images) and while they interact with them, different user aspects are extracted, like personality traits, such as cognitive style, specific interests, collaboration patterns with others, etc.
- Social media interaction analyzers, which analyze interactions between users within social media (posts, tags, likes etc.) to determine users profile traits as well as influencing individuals. The social media analyzers allow the identification of influential discussions on social media and study their characteristics, giving the opportunity to different institutions like cultural venues to duplicate such influential conversations. In addition, people with high influential traits are also identified.
- Social media content matchers, which correlate current discussions on social media to any provided content (such as the content of a cultural venue) to identify discussions and trending topics that are similar to the content of the venue; then these matches can be used to more effectively promote the content of the venue allowing venues to engage meaningfully in ongoing discussions and promote their content.
- Microaugmentation delivery toolkits, to help re-capturing the interest of a user after prolonged periods of inactivity. Micro-augmentation is a content delivery method as well as a content creation method. The content is designed in a way that maximizes curiosity and engagement and it is delivered in ways that also increase visitor attention.
- Timeline visualization gadgets, comprising user interface components to display and interact with timelines.

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