Universal Access in the Information Society

Enhancing accessibility in Cultural Heritage environments: Considerations for Social Computing

--Manuscript Draft--

Manuscript Number:	
Full Title:	Enhancing accessibility in Cultural Heritage environments: Considerations for Social Computing
Article Type:	Communication
Funding Information:	Horizon 2020 Framework Programme (692058) — Not applicable
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Enhancing accessibility in Cultural Heritage environments: Considerations for Social Computing

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Abstract

Current technological advancements offer many ways of enhancing disabled peoples' access to Cultural Heritage environments. A new generation of Social Computing technologies and systems is changing the way in which we access Cultural Heritage, facilitating the inclusion of socially isolated groups of people. Under this perspective, this paper aims to explore the potential impact of Social Computing systems to enhance people' access to Cultural Heritage, particularly focusing on deaf and disabled users. By reviewing the current literature on Social Computing and Cultural Heritage, the paper first summarizes the related applications and appropriate key technologies; second, it provides examples of innovative approaches to the enhancement of user-engagement and interaction through social computing. Moreover, the paper highlights arising issues of privacy, as well as ethical considerations, and presents design principles for ensuring privacy. The study concludes by discussing challenges for inclusive Social Computing applications in the context of Cultural Heritage and pointing out areas where future research is needed.

Keywords: Social Computing, Cultural Heritage, disability, accessibility, social interaction, information modelling, deaf, privacy

1. Introduction

Social Computing, henceforth SC, is defined as "computational facilitation of social studies and human social dynamics as well as the design and use of ICT technologies that consider social context"

[1]. Based on the literature, SC can be interactive and collaborative as it facilitates communication between people. SC environments allow people to interact in many different ways. Examples of SC technologies include social media sites and networks, e-mail, discussion forums, blogs, wikis, instant messaging, games, and open-source development.

More recently, the rise of SC tools has influenced information systems and applications and strongly received researchers' attention with a particular interest to its social implications for helping people access Cultural Heritage environments [2]. Indeed, social technologies, and especially social media applications, affect both access to and the character of the cultural activity. Cultural Heritage (CH) constitutes an interdisciplinary area, comprising a broad spectrum of functions related to the study and the preservation of both physical evidence of past human activities and intangible societal attributes from past generations. Experiencing Cultural Heritage (CH) people can participate in various cultural performances, visit historical monuments and buildings, as well as archaeological sites. Additionally, CH could consist of other examples of human creativity and expression such as books and manuscripts, instruments, photographs, etc., as well as whole towns and natural environments.

A significant amount of studies has investigated the use of different technologies for CH purposes. Specifically, virtual environments or objects, interactive applications, and serious games have been used to engage people in the CH of different countries and civilizations. Technologies mentioned above are often placed in museums and other cultural sites/environments and monuments accessed by visitors from around the world [3] [4] [5]. Moreover, many SC systems and tools have been used as parts of innovative teaching/learning methods for educational purposes boosting the learners' interest and engagement in CH [5] [6]. To that end, SC has the potential to cultivate the education of the new generations in a vivid and pleasant manner, engaging them to immerse themselves into aspects of CH they were unaware of, while also promoting user-to-user communication through the creation of single or multi-user interactive systems[5].

Researchers and practitioners in the CH area are trying to make existing material related to CH accessible to a broad public adopting SC tools as a means for presenting their collections [7]. For this reason, CH through the use of SC empowers all people and offers opportunities for participation in various landscapes and identities [8]. CH can be seen as a means to interact meaningfully with our past and shape our vision of the future [9] [10]. Nowadays, the increasing use of emerging technologies and digitally mediated heritage forms enable people to participate continuously in CH activities [8]. Specifically, many CH institutions are urged to use such emerging information and communication technologies to encourage people to interact with CH content actively and connect socially with one another [11].

As a consequence, the use of SC may contribute to engaging people in CH environments by helping them to recognize and appreciate the value of CH. According to a *Design for all* approach, emphasizing the right to equal opportunities for all people, CH resources can and should be available for both disabled and non-disabled people. Thus, today access to CH environments and assets is potentially enlarged as the use of emerging technologies and tools has largely increased. Practitioners, designers, and researchers are now trying to use more technology-based materials that can be more easily accessed and used by all people in an inclusive context. This ambitious perspective can make CH patrimony common for all people, including people with any physical or mental disability. It also enhances the right of all people to have the same opportunities [12] [6].

This study reflects on the potential impact of SC systems and technologies to enhance peoples' access in CH communities and environments. The work also presents recent work related to the engagement of vulnerable groups of people in CH, and addresses issues of privacy and ethics emerging from the use of social computing applications, and identifies potential research and future work directions. In what follows, we first address aspects of CH which are related to SC, by presenting the existing approaches and challenges related to CH information modeling, storage and retrieval. Subsequently, a review of recent empirical research regarding the access of disabled people and in particular the deaf and blind in CH resources is provided, followed by an analysis of privacy issues with regards to interactive exhibits.

2. Cultural Heritage Information modelling

A variety of information types exist in the domain of CH: despite the effort towards digitizing information and creating data models with semantic information regarding CH [13], the majority of information remains unstructured. Large amounts of data include unstructured information in the form of multimedia such as images, videos, textual descriptions and analyses, and audio content. To that end, the systematic modelling of a large amount of information is the ability to store information in a format that is easy to be queried and accessed, thus allowing to process it and facilitate the creation of a variety of CH visualization applications.

A potential approach for data modelling is the use of ontologies. Ontologies define and classify concepts and entities and the relationships between them. CIDOC-CRM provides an extensible ontology for concept and information in cultural heritage and museum documentation [14]. Its purpose is to allow domain experts and implementers to conceptually model data and act as a mediator between different sources of cultural heritage information. For instance, Doulaverakis et al. [15] adopt CIDOC and use ontologies as a tool for information retrieval and online search inside multimedia heritage collections. Another interesting approach is the integration of CH data within Big

Data key-value structures. Such an example is SCRABS [16]; this work includes distributed data models such as MongoDB and HDFS and showcases a scalable prototype for the management and context-driven browsing of cultural environments.

Several efforts have been undertaken to organize and structure cultural information: The New York Metropolitan Museum of Art[1] has created a large dataset with information on more than 420.000 artworks in its collection for unrestricted commercial and non-commercial use. Europeana[2] is an established digital platform for CH, providing access to digitized works and semantic information related to CH in the European Union. Information is structured using the Europeana data model (EDM) [17], which allows finer granularity and richer metadata. Additionally, Open Heritage, Google's cooperation with CyArk[3], aims to allow users to remotely explore iconic locations in 3D by providing access to 3D CH monuments.

2.1 Interactive Cultural Heritage Institutions

CH institutions, such as museums, archaeological sites, and libraries employ a variety of technologies in an attempt to foster user engagement. Interactive technological applications were initially met with skepticism by the institutions, as there were concerns that users' attention would shift from the exhibits to the installations and would produce controversial results. Information accompanying CH exhibits was traditionally met with textual data, such as labels describing the specific exhibits and textual descriptions of its context, possibly enhanced with explanatory photographs or reconstructions. Nowadays, interdisciplinary research efforts have led to joint outcomes, as CH experts in cooperation with data scientists are producing scientifically accurate visualizations which allow users to explore narrations interactively.

Several domains are employed in the context of CH visualizations, such as infotainment, gamification and serious games, narratives, immersion, and presence in Virtual and Mixed Reality, directly related to SC. These domains share the goal of acting as educational tools for the promotion of CH in a pleasant manner, by presenting stories in which users are immersed, providing a vivid and engaging experience. Static visualizations have been traditionally employed to support storytelling in the form of text, diagrams, and images. The adoption of dynamic approaches utilizing state-of-the-art 2D and 3D graphics is emerging in an effort to explore the full potential of interactive narration. As stated by [18], visual storytelling can be adapted to provide an intuitive and fast exploration of very large data

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[1] https://www.metmuseum.org/

[2] https://www.europeana.eu/portal/en

[3] http://cyark.org/about/openheritage

resources in real time. Storytelling using MR and AR applications has the potential to foster creativity, combining education, social interaction and gamified user experiences [19].

2.2 Applications and Interaction in Cultural Heritage environments

Papagiannakis et al. [20] present a comprehensive taxonomy of visualization strategies, focusing on the aspects of (i) precision and visual consistency, (ii) interactivity and (iii) automation. User engagement constitutes a fundamental aim for applications presenting CH information. Gamification is an approach towards increasing entertainment and user motivation [21]. MR environments are integrated into CH institutions, associating virtual artifacts with physical exhibits. In terms of interaction, apart from traditional desktop interaction (i.e. keyboard, mouse and touch screens), several approaches exist in the literature which employ alternate interaction modalities in order to be more natural, user-friendly and improve the user experience. Several modalities are integrated into in vivo and in vitro setups attempting to enhance immersion and improve the user experience. Approaches vary in terms of interaction richness, as the selection of the interaction modality is largely defined by the purpose of the deployed system.

The factor of pleasure and engagement is apparent in applications which employ kinesthetic full-body interaction [22]. Body movement and gestures constitute an aspect of our everyday life which is natural for everybody: therefore, the challenge of turning instinctive modalities to communicate messages with non-living objects provides a fascinating user experience [23]. Body movement in the form of walking in a room can act as an interaction method via computer-vision based non-instrumented human detection, facilitating both implicit and explicit interaction not only in CH installations [24] but also within educational contexts [25] [26]. Another common interaction technique is mid-air hand gesturing: users are able to simply point in order to retrieve additional information about exhibited artefacts [27], browse a multimedia collection [28] reveal additional information by lighting exhibits [29]. Furthermore, more complex hand gestures including grasping and manipulating 3D objects are presented by [30] to interact with CH exhibits in the context of Virtual Reality applications.

2.4 Multi-user interaction

Social implications are evident in the context of multi-user interaction, where the occasion exists for people to trigger social interaction and facilitate user-to-user interaction. Multi-user interaction with public displays, like the ones located in CH institutions, constitutes an active area of research in the context of SC. The honey-pot effect [31] constitutes an indicative effect of interactive displays on social interaction and human behaviour: once a user identifies an interactive system located in a public setup, a progressive increase in the number of people is usually noticed in the vicinity of the display. Once people approach the interactive display, they decide their actions with regard to the system. Especially in the context of MR applications, the establishment of interaction with a public display involves transitioning from implicit to explicit interaction [32] as the users become engaged to the pervasive display. Users tend to follow two different patterns of concurrent interaction, parallel use and teamwork [33]. In the case of social interaction between users, role taking is identified as a way to deal with the complexity of the social setting and allow multiple participants to act at once. A common social role during the hands-on interaction with digital exhibits is the role of a mentor, which is taken by users that are either very familiar with the interaction technique applied or have simply used the exhibit before [34].

Aspects like collaborative or competitive interaction can provoke social interaction, acting as a starting point created explicitly by interactive systems. Additionally, role-playing is another characteristic to be considered, as social interaction can be triggered with the excuse of interactive applications. These remarks highlight the potential of multi-user human-computer interaction in terms of social interaction, especially when interaction includes multiple users.

3. Disabled people and Cultural Heritage

3.1 Accessibility in the context of Cultural Heritage

Majewski and Bunch [35] argued that we cannot truly fulfill the requirement for making museums accessible until we can accept people with disabilities as a contributing part of our past, present and our future. They emphasize that full accessibility is beyond ramps, bathroom grab bars, and access to all the floors of the museum, but it goes as far as deaf people, those with low vision or cognitive disabilities, which require more attention to matters of how they present their exhibits rather to how the building is structured. They also state that museums must stop doing just enough to be legally compliant, but should integrate sensory and cognitive concerns during exhibition development process and include exhibitions' reflections of experiences of people with disabilities. Different learning styles must be addressed as well as multisensory approaches. Sandell [36] explored the ways museums can engage with an impact upon social inequality, discrimination and disadvantage. His framework shows that museums can impact with a positive way on the lives of disadvantaged and marginalized people, facilitate social regeneration, empower specific communities and create more equitable societies.

The UK government has identified "the arts", including museums and theatre, as a mechanism through which marginalized individuals and groups can be included into physical spaces and activities of society. This includes disabled people who have found opportunities to build self-confidence, interact with others and gain skills, in activities related to creative arts [37] [38].

Sandell [39] highlighted the need for socially inclusive work training, from pre-entry professional training courses to ongoing opportunities, for continuing professional development. Also, other innovative methods of training and development may be more effective in beginning to shift deeply held beliefs and attitudes. At Nottingham Castle Museum and Art Gallery, the Drawbridge Group, a consultative group of disabled people, devised and delivered relevant, tailored training, in a non-threatening environment, for all museum staff in disability awareness. It was effective in encouraging, amongst individuals, increasing recognition of their responsibility to consider access issues in their daily working practices [40].

Although some countries have introduced legislation to promote equal rights for people with disabilities, historical buildings and sites of interest are protected under national planning regulation that makes it difficult to make improvements to their physical access. In a study by Goodall's et al. [41] the significance of historic environments for tourism in the UK is outlined and the barriers that are restricting tourists with disabilities going to archaeological sites were reviewed from the heritage tourism service providers viewpoint.

In a study by McMillen [42], six disabled participants toured an art museum in Central California, while they were observed by a researcher. They were then asked questions about their experience at this museum and on topics like social inclusion, disability access and new media. The analysis of their responses showed that the participants felt socially included when they could identify with the exhibitions, but they felt socially excluded when they perceived mental or physical barriers. The physical barriers dominated the focus discussion they had with the participants noting that some exhibits were displayed too high for them. In general, the participants wanted to be included and empowered. McMillen notes that that museums should utilize new media strategies to enhance disability access like touch or interactive exhibits as their participants suggested and hoped for a better audio tour. He highlighted the need of an additional study on how connected people are to technology and whether social media could enhance museum access.

A way to conserve cultural heritage and ensure permanent access to information is through digital preservation and CH institutions should act on that. According to Evens and Hauttekeete [43], governments have a crucial role in opening their archives and digitalizing them. This could facilitate the accessibility of heritage exhibits and collections. With the latest developments in technology, investments in digital heritage would allow institutions to engage audiences and develop mutual relationships with other stakeholders. Additionally, increased accessibility would allow disabled and younger people to access all this content too. By doing this, it would make even more people participate in culture and include marginalized groups in the knowledge society.

Physical access for the disabled is something that cultural institutions like museums need to consider very seriously. However, something that is usually ignored is online access for the disabled to the websites of these institutions. A study by Bowen [44] tried to help raise awareness of the issues concerning online disabled access. The internet has become the biggest communication medium and institutions must ensure that their online resources are accessible as widely as possible for all users (blind, partially sighted, deaf, paralyzed or otherwise disabled). Improved accessibility will widen the number of people using the technology, addressing barriers resulting from disability. People with disability have a right to have access to cultural heritage websites and according to a museum website accessibility survey by Micheloni and Bowen [45], the emphasis for more accessible websites should be given on the web pages coding practice.

In a similar study, accessibility issues for museums were explored by Lisney et al. [46] in the context of digital access through the Web and mobile devices. They aimed to provide museums an insight of a disabled person's view, by describing their own personal experiences, as the authors were people with different disabilities themselves. According to them, the internet can transport people into the world of arts and culture in any gallery and museum, and disabled people have a right to be part of this process.

Archaeological sites or museums are often not that easily accessible to physically disabled people due to mobility restrictions, lack of ramps, and distant location. With recent advances in VR technologies, it is now possible to virtually reconstruct sites and museums so that they are easily accessible by anyone. Christofi et al. [47] developed a VR application reconstruction of the archaeological site of Choirokoitia in Larnaca, Cyprus. The virtual reconstruction of this site simulates its current state and is based on real data acquisition like photographs from the actual site. It allows the users to virtually navigate through the archaeological site and acquire historical information for various important points of the site.

Disabled people might not travel to other countries due to mobility issues and this makes it hard for them to visit museums or experience the CH of other countries. A VR application developed by Pappa et al. [48] allows users to be immersed in a virtual roller coaster, taking a virtual tour of selected European countries. More specifically, the user moves on the roller coaster and is able to see on the sides various 3D objects related to the tangible and intangible CH of that country alongside a description of that object.

3.3 Accessibility in Cultural Heritage and applications for Deaf / Hard-of-Hearing users

According to Kawashima [49], cultural institutions should be inclusive and accessible to all people in society. The accessibility and inclusivity of disabled people in cultural heritage resources and institutions can be achieved through outreach. Kawashima [49] argues that the concept of outreach refers to the process of taking CH resources away from their usual location to areas where the audience has limited access. Reaching out to different social groups with the works of art helps to reduce social exclusion and increase accessibility for vulnerable groups in society [50]. Museums are important agents of cultural outreach because they are able to reach out to various social groups such as deaf people through learning programs, exhibitions, and experiences.

People with hearing impairment specifically face challenges with accessing museum content because they cannot receive cultural information through audio channels [51]. One of the strategies used to include deaf people in cultural museums is the use of information technology. According to McMillen [42], museums have adapted to the changing environment by developing innovative ways of promoting social inclusion.

Constantinou, Loizides, and Ioannou [52] have described one of the projects that use information technology to allow deaf people access cultural heritage information. The authors emphasize the use of digital technologies to increase the accessibility of CH information for hard-of-hearing users. Researchers investigated how an interactive screen technology is used to disseminate information to deaf people without the guide of a language interpreter. The study found out that the use of interactive applications in the museum increases the level of user satisfaction and promotes enjoyable cultural experience among deaf visitors. The user-centered design of the application followed three design cycles involving 68 participants. The personalized application was developed on Android mobile to enable deaf visitors to the Pattichion Municipal Museum to access information about cultural exhibits directly through their mobile phones. Based on data analysis, the application was effective in promoting inclusivity in CH, because it created a pleasant experience and provides freedom and independence for people living with hearing disabilities.

Similar attempts to incorporate information technologies in museums have been experienced across the world. Various researchers agree that the use of digital media technologies in museums improves the user experience [53]; generates interest and knowledge [54]; and provides entertainment to deaf people [55]. Paternò and Santoro [53] suggest that appropriately designed applications provide innovative ways of exploring the museum and accessing information about exhibits. Brice and Straus [56] also postulate that the use of assistive technology improves communication with deaf and hard-of-hearing people, leading to better outcomes. Thus, the use of assistive technologies such as mobile applications is important for improving the experiences and cultural heritage outcomes of deaf individuals.

There are certain guidelines for designers to develop appropriate assistive technologies for deaf and hard-of-hearing visitors in museums. According to Proctor [54], visitors with hearing impairment have several access options. For instance, the audio tour model incorporates four capabilities: audio tours, text guides, audio-visual tours, and audio and text tours. The audio tours should be enabled with volume control features, clear and easy to understand narrations, and hearing aids. The text guides should also be enhanced with regular and large print scripts, catalog, and text booklets. Furthermore, Proctor [54] suggests that the audio-visual tours should be accompanied with automated sign language guides to enable deaf visitors to access exhibit information without the support of interpreters.

Othman, Petrie, and Power [57] also note that museums are increasingly deploying smartphones to provide an easy and convenient guide for visitors without the need for heavy investment in audio guides. They have investigated the scale used in measuring the usability of smartphone guides in museums. There are two types of smartphone tour guides examined by the researchers: free choice tour (FC-tour) and guided tour (G-tour). The free-choice tour is based on the free-choice learning in which an individual is allowed to discover knowledge without support from a teacher or guide [58]. On the other hand, the G-tour involves the traditional approach of using a mobile guide to demonstrate how things should be done. The free-choice tour enhances improved learnability and control while the guided tour improves general usability [57].

The use of both G-tour and FC-tour is essential for people with hearing impairment because they allow the visitors to retrieve meaningful information easily. Schilit, Adam, and Want [59] also suggest that multimedia guides deaf people to develop knowledge and understanding about exhibits and gain meaningful experience in the cultural space. Free choice tours help deaf people to control their learning and access of information in the museum; while the guided tour enables them to gain meaningful experience without having to learn new technologies [60]. Thus, the use of smartphone guides is generally effective in promoting social inclusion and accessibility of meaningful information for deaf and hard-of-hearing visitors in museums.

Furthermore, the guided use of hearing assistive technology (HAT) in a museum tour is beneficial to people with hearing loss. According to Meyer et al. [61], docent-led tours with hearing assistive technology increase accessibility, social connectedness, and quality of life among people with hearing impairment. The researchers propose that museums should train guides to use hearing assistive technology to improve the cultural experience, accessibility, and social inclusion of people with hearing loss in cultural sites.

Multisensory programming technologies may also be used to improve the cultural experience of people with hearing disabilities in museums. A pilot multi-sensory program developed by Lurio [62] is used to allow visitors with autism to incorporate various sensory elements such as taste, smell, and touch. The approach is beneficial for deaf people because it enables them to engage with the cultural past without verbal or hearing experience. Thus, multi-sensory programs promote improved experience of cultural heritage, social inclusion, and accessibility of cultural sites for people with hearing disabilities.

Considering the above, the use of information technology enables museums to increase access to deaf people who are unlikely to experience cultural heritage without using special programs or applications. Sandell [63] argues that a museum should be inclusive, an agent of social regeneration, and a proxy for broad social change. Museums should remove all barriers that prevent people with disabilities from accessing cultural information [64]. Technological innovation may prevent the physical barriers of accessing audio information in the museum.

4. Privacy and ethical considerations in SC for CH

Social Computing implies - by definition - interaction among stakeholders of a computer system. In general, social communication requires us to trust those with whom we interact with the purpose of achieving some personal and/or collective goal. In the case of Social Computing for Cultural Heritage, the purpose of interaction may be, depending on the participants and the context, both personal, e.g. for educational purposes and collective, e.g. social development. Social Computing facilitates communication of persons corresponding to diverse groups with respect to language, ethnicity, religion, age, gender, several other cultural aspects but also diverse social and mental skills and physical (dis)abilities. Engagement of persons, especially those with characteristics which may undergo social discrimination, requires that the system takes into account their privacy and respects relevant ethics.

According to the definition by van Rest [65], "privacy is the ability to control and limit physical, social, psychological and informational access to the self or one's group". Of those four kinds of privacy we are especially interested in informational privacy, as it is the most related to SC. DeCew [66] describes as private that kind of information which is related - but not limited - to "one's daily activities, personal lifestyle, finances, medical history, and academic achievement". Himma and Tavani [67] further divide informational privacy into four factors: (1) the amount of personal information that can be collected, (2) the speed at which personal information can be exchanged, (3) the duration of time that the information can be retained, and (4) the kind of information that can be acquired. All these factors are of particular interest of systems in the context of SC, where privacy corresponds to personal data that are collected for the purpose of operating means of e-communication or for user analytics.

"Ethics" (equivalently "morality") is described by Tavani [68] as those directives and social policies which guide individuals and societies on their custom, habit, behavior, and character. A specialized notion of ethics, called "cyberethics", is presented by Tavani [68] as the study of moral, legal, and social issues involving cybertechnology. Ethical issues arise due to the involvement of SC and especially applications based on Social Communities and Virtual Reality in applications related to CH.

The characteristics of interactive installations and mobile applications in the context of CH can be classified into two categories, a) personal or other kinds of data that are collected during user engagement and b) existing data and methods of their processing within systems.

4.1 Personal & other data

According to GDPR[4] and relevant EU regulations and directives, "personal data is any information that relates to an identified or identifiable living individual". Examples of personal data include name and surname, home, e-mail and IP addresses, location data and photos in some cases. Such data are occasionally required from mobile applications related to CH for various reasons. For instance, name and e-mail address are utilized for authentication and profiling and GPS or WiFi localization data are utilized for user analytics near places of interest. Moreover, some applications include operations for capturing and possibly uploading photos/videos of interest. Although multimedia content is appealing in SC, there is a possibility that it comprises private data of persons who have not given consent for them or corresponds to material protected by copyright.

4.2. Existing data and processing

Beyond standard means of interaction and user engagement, CH systems nowadays incorporate technologies based on Computer Vision (CV), Machine Learning (ML) and Virtual Reality (VR). CV/ML have been applied to those systems to achieve human body tracking, face detection, action recognition, thus enhance user experience. CV was revolutionized recently due to advances in ML and in particular with emergence and wide adoption of algorithms based on Convolutional Neural Networks (CNN), while raising privacy and ethics issues due to dependency on public data for learning [69] [70].

The six categories of ethical issues related to CV that were recognized by Lauronen [71] are espionage, identity theft, malicious attacks, misinformation, copyright infringement and

[4] https://ec.europa.eu/commission/priorities/justice-and-fundamental-rights/data-protection/2018-reform-eu-data-protection-rules_en

discrimination; we will discuss the two last. Lauronen relates copyright infringement issues to CV applications due to the fact that pertinent algorithms utilize databases which might be susceptible to either copyright or privacy violations. In the context of CH, such databases may contain copyrighted images (e.g. artwork), video (e.g. live acts) or depict persons in public spaces. However, claims for copyrighted material are mostly part of legal investigation and require consideration before system installation, thus are loosely related to end users.

On the other hand, discrimination due to algorithmic failures or design choices is of great importance and most relevant to end users of SC for CH. Discrimination is discussed in Zou and Schiebinger [72], where it is argued that CV/ML systems are gender- and skin color - biased. That is explained by the fact that most CV/ML systems "learn" from datasets whose content is biased towards certain person groups. An example given in the above work, is a flawed translation algorithm (such as Google Translate) which is driven by the ratio of masculine to feminine pronouns in English, resulting to increased relative frequency of the masculine one.

The emergence of VR technologies has led to realistic environments applied to both game and interactive applications, but has also raised ethical controversies due to immersion, as presented in Tavani [68]. Ethical issues are discussed in two ways; related to behavior and to representation. Controversies related to behavior are raised because one is intended to act as someone else within the context of game or application, possibly performing actions that wouldn't take in real life. To extent such remark in the context of SC, one can think that in a hypothetical collaborative VR game some of the participants might not take their act as seriously as the others, therefore disrupt expectation about what happens in real life. In Brey [73], issues about representation of information in VR are suggested to morally harm the experience. Representations can be problematic as soon as they correspond to one of the following: 1) misrepresentations, which fail to uphold standards of accuracy; 2) biased representations, which fail to uphold standards of fairness; 3) indecent representations, which violate standards of decency and public morality. Such issues are due to expectation of engaged persons for more realistic environments.

4.3 Design principles

Preservation of values of ethical importance as those discussed in the previous sections, are presented in early literature [74]. Since then, a more integrated framework called Value Sensitive Design (VSD) has been proposed [75]. As stated in Friedman et al. [76] "Value Sensitive Design is a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process".

VSD consists of an iterative process which integrates conceptual, empirical, and technical investigations [76]. Conceptual investigation includes an identification of the values that should be supported, trade-offs between competing values (e.g. autonomy vs. security) and prioritization of values (e.g. moral above others). Empirical investigation is related to standard HCI design process in the context of what stakeholders think about values, for example how stakeholders apprehend individual values in the interactive context or how do they prioritize individual values and usability considerations. Relationships between usability and human values with ethical impact are complex, therefore in contradictory cases HCI designers should prioritize on one or the other to create a viable design. Technical investigation focuses on (1) how existing technologies support or hinder certain values and (2) how values identified during conceptual investigation could be incorporated within system design. Two examples are presented by Friedman et al. [76]. In the first case, a hypothetical collaborative video-based system may or may not blur the background of the video feed of each participant, therefore prioritize an individual's privacy or group's awareness of individual members' presence and activities. In the second case, a collaborative system may utilize by design a value hierarchy, for example by providing the tools to prioritize individuals' desire for privacy with respect to other group members' desires for awareness.

In more recent work [77], VSD is on the one hand considered a useful tool, while on the other it is criticized for "over claiming" in various aspects. In favor of its further adoption and appropriation, four directions are presented. First, it is proposed that designers should better consider universal versus culturally-specific values. That is in contrast to traditional VSD which states that values are universally held. Second, it is stated that context is of particular importance, therefore list of values presented by works in literature may not be appropriate in other contexts (e.g. cultural), or may introduce bias during conceptual investigation. Third, it is suggested that end-users should be better engaged in a co-design process. That is due to their remark that researchers are more involved in interpretation and report of qualitative results, than the actual users of the technology. Fourth, they insist that individual researchers' opinion should be more salient, meaning that personal opinion, background to the topic and values should be reported, as well.

Jacobs and Huldtgren [78] argue that VSD should be complemented with a particular ethical theory, for being able to distinguish moral values from mere preferences. They propose that a so-called mid-level ethical theory is suitable, also giving some desired properties. They propose that such theory should be governed by explanatory power, justificatory power, simplicity and practicability. Exemplar theories which follow their expectancies include [79]. Towards a practical application of VSD, Heger et al. [80] propose an easy-to-implement method which they call "value declaration". Their methodology has been applied into two design-oriented research projects. They present the opinion and remarks of relevant stakeholders, concluding to the usefulness of their approach.

As presented previously, privacy is a core value examined by VSD. A specialized methodology with respect to preservation of privacy is the so called Privacy-by-Design (PbD) framework, initially presented by Ann Cavoukian [79]. Its purpose is to embed privacy measures and privacy enhancing technologies (PETs) directly into the design of information technologies and systems [81], while it was also incorporated in GDPR. The framework comprises 7 principles, (1) Proactive not reactive, preventative not remedial, (2) Privacy as the default setting, (3) Privacy embedded into design, (4) Full functionality (positive-sum, not zero-sum), (5) End-to-end security (full lifecycle protection, (6) Visibility and transparency (keep it open), (7) Respect for user privacy (keep it user-centric).

Some indications about PETs are presented in a recent report by EDPS [82]. One of them, a design strategy called "attribute-based credentials", encourages designers to adopt specific cryptographic concepts such as zero-knowledge proof, which permit selective disclosure of one's identity. For example, an application of such strategy within an adult-only service, is to disclose only "older-than-eighteen" information rather than specific age or other identity attributes. Advances in other technologies including decentralized messaging services with end-to-end encryption and Do Not Track (DNT) features on modern web browsers, prove that PbD is nowadays feasible [82]. The lack of holistic framework for translation of PbD principles into engineering approaches, motivated Alshammari and Simpson [83] to present a principled approach towards this direction. They initially introduce a set of guiding principles, complementary to PbD, for embedding privacy into the system development life cycle. Subsequently, they present their thoughts for a framework for engineering PbD. These include careful examination of the personal data lifecycle such that it is feasible for analysis, adoption of a data-centric method in order to identify potential privacy violations in each stage of the personal data lifecycle, development of privacy design strategies capable of addressing privacy concerns at architectural levels and a set of privacy-guided methodologies that can be incorporated into the system development lifecycle.

An additional aspect which should be considered during the design of privacy compliant systems is security during processing of private data [84]. For this purpose, a privacy risk assessment framework is proposed in a report by ENISA [85]. Its goal is to assess security risks and adopt security measures for the protection of personal data. The framework comprises of four steps: (1) definition of the processing operation and its context, (2) understanding and evaluation of impact, (3) definition of possible threats and evaluation of their likelihood (threat occurrence probability), (4) evaluation of risk (combining threat occurrence probability and impact). The application of the framework is presented through various use cases, while a number of conclusions are drawn. Among others, it is stated that the overall risk based methodology cannot be a "one-size fits all" approach, but data controllers should first take into account the context and environment of the data processing and comprehend processing operations.

5 Discussion and Conclusions

This paper has presented an extensive overview of the literature addressing Social Computing in the context of Cultural Heritage, with a particular focus on issues of accessibility, social inclusion and privacy. Examples of technical approaches as well as various applications for the domain of Cultural Heritage (including Cultural Heritage resources and institutions) have been provided. Particular focus has been given to address fundamental issues of privacy and present considerations for the ethical use of social computing applications, also for the domain of cultural heritage.

Based on the literature, SC systems and technologies can positively engage people in CH environments enhancing the dissemination and preservation of our CH. Practitioners in the CH area are working on that perspective in order to make CH material accessible to a broad public. CH through the use of SC empowers all people and offer possibilities for active participation and involvement in various CH landscapes and environments. Moreover, the use of SC can contribute to engaging people in CH environments by helping them to recognize and appreciate the value of our CH.

State-of-art solutions in voice interaction, scanning, visual layout adaptation, touch and haptics interaction, gestures, eye tracking, head pose interaction, sign language, persuasive and affective interaction, serious games, and augmented reality offer numerous possibilities for the development of inclusive social computing applications, particularly in the domain of CH.

At the same time though, a number of challenges affecting the design and development but also the acceptance of SC applications, need to be addressed. CH is only an example of a domain that is directly affected. First of all, design efforts should be made towards the *social* aspect of interaction; careless design, might result to users that are isolated from each other. Second, the design should focus on the content, while the technology should be present solely as facilitator. That is to keep interest on the content rather to technology itself. Third, information visualization should always be grounded on the principles of Human-centered Design.

It should be noted that there are limitations regarding SC applications within CH institutions and environments. Indeed, existing frameworks which address ethics and privacy issues are more a set of guidelines, rather than applied methodologies. Also, most of them stress that such investigation should be done into a specific context (e.g. cultural). Nevertheless, SC acts as facilitator for inter-cultural communication, thus context may be specified differently for each end-point or end-user. For example, an overall approach for the entire system may not be appropriate.

Closing, SC applications can help people to engage in CH activities giving them opportunities for participation and social interaction. However, more research is necessary to address issues affecting the accessibility of people in CH environments. Future studies could work on the development of methodologies, interactive spaces and tools to enhance the accessibility of all user groups for CH purposes. Overall, this study maps the existing literature and empirical work on the use of SC for CH, providing a deeper understanding on how SC can enhance the peoples' access in cultural context, taking into account privacy and ethical issues.

Acknowledgments

Part of the work in the context of this paper has been the result of PhD student exchanges between CUT and FORTH-ICS, funded in the context of the European Union's Horizon 2020 Framework Programme through NOTRE project (H2020-TWINN-2015, Grant Agreement Number: 692058).

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