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Figure 1: Components of SenseVase with Virtual Memorial (Left: SenseVase, a sensor embedded vase that detects if flowers are put inside; Center: an app for finding and visiting existing memorials, creating a new memorial with your original configurations, and managing your favorite memorials; Right: Putting flowers inside the vase will lead to a virtual floral tribute being given to an online Virtual Memorial illustrated in 3DCG)

ABSTRACT

While floral tributes are commonly used for the public commemoration of victims of disasters, war, and other accidents, flowers in vases color everyday life. In this research, these features of flowers are intertwined with the recent phenomenon of online memorials to develop a virtual floral tribute concept that includes physical rituals. We designed SenseVase, a smart vase to detect flowers placed in it, and a 3DCG Virtual Memorial that illustrates floral tributes given by people using SenseVases at home. This paper describes how we developed our design concept by reviewing previous literature and social aspects, and presents a video illustrating the concept. To validate the current concept, we interviewed several

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experts knowledgeable in public commemorations, virtual and online communities, and the floral business. Through a discussion of our findings from the design process and interviews, we propose a new direction for how HCI technology can contribute to public commemoration in addition to personal memorialization.

CCS CONCEPTS

 Human-centered computing \rightarrow Human computer interaction (HCI).

KEYWORDS

Mourning; Memorialization; Commemoration; Online Memorial; Death Rituals; Techno-spiritual Practices; Thanatosensitive Design; Research through Design

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1 INTRODUCTION

In front of the memorial monument in Hiroshima Peace Memorial Park designed by Kenzo Tange, a lot of flowers are left by mourners every day (Figure 2), despite seventy six years having passed since World War Two. Floral tributes are one of the most common ways to commemorate the deceased, especially when paying respects to the victims of public incidents such as war, accidents, terror incidents, and so on.



Figure 2: The atomic bomb dome and the memorial monument with floral tributes in Hiroshima Peace Memorial Park

However, many memorial monuments or places of commemoration have to be removed after a certain period of time (e.g., [10, 17]). Organizers (sometimes a municipality) of temporary floral tributes have to remove everything eventually. Another reason floral tributes are removed is because they occupy public spaces, sometimes in violation of local laws (e.g., [8]). These removals incur huge costs to the organizers and municipality. Permanent tributes, such as those made to commemorate the 9/11 attacks in New York City and the Hiroshima and Nagasaki atomic bombs, are similarly expensive to maintain due to their large size and high standards of cleanliness. However, it is now difficult to physically visit memorials, since people all over the world are facing the COVID-19 pandemic.

Instead of physical memorials, space for memorialization has been spreading online. Facebook provides "Memorialized Accounts" [22], a function that enables a particular user account belonging to the dead to be closed or changed to become an online memorial platform (e.g., [13, 26, 30, 80]). In the United States, there are some cases in which the commemoration of those killed in accidents continues online after their physical memorial monuments have been removed [17].

However, existing online memorialization places do not provide physical rituals such as offering flowers, candles, or incense, though these web sites enable us to remember dead people by archiving their information [27]. Physical and embodied rituals have important roles for people who lose loved ones as they can help them accept the deaths and move on [66]. Our motivation in this research is providing a way of commemorating the deceased online with embodied rituals that are widely adopted by people through memorialization.

We propose a set of components named "SenseVase with Virtual Memorial" (hereafter SV-VM) that consists of an interactive flower vase (SenseVase) and a virtually produced memorial site (Virtual Memorial), as shown in Figure 1. SV-VM is a conceptual example of an online public memorial in the VR environment that is similar to emerging social VR communities [48]. SenseVase is embedded with infrared sensors on the bottom, detects its contents, and recognizes its condition; if it is filled with water and how many flowers are inside. When the user puts flowers in the vase, a Virtual Memorial working on Unity receives signals from the vase, and virtually displays flowers. In addition, by using a smart phone app, users can configure settings on Virtual Memorial. Through the app, they can create a new memorial, select an existing memorial to pay tribute to, and manage their list of favorite memorials. Our initial design concept and prototype is illustrated in the attached video¹. The concept can be expanded and will be able to provide virtual mourners with a sense of community by supplying vases and implementing a function for creating several monuments for individual incidents.

This paper illustrates a concept of online public commemoration with embodied ritual(s), describes our process of creating SV-VM, qualitatively validates our current SV-VM concept through five interviews with experts, and suggest several implications for the design of virtual memorials. One notable result of the interview is that, despite of our initial motivation and presentation of SV-VM as a means of public commemoration, some experts suggested ideas to use SV-VM for private memorialization. This might be a result of the COVID-19 pandemic which has caused difficulties in memorializing loved ones. Therefore, we will also discuss how SV-VM could be applied for private rituals such as memorializing deceased family members, ancestors, friends, etc.

This research envelopes several research areas, so, first we provide a literature review of the pertinent subjects. The review defines why we need to investigate this issue and what we need to design in the research areas. Secondly, we will describe the concept of virtual commemoration online with interactive devices enabling users to hold embodied rituals and the detailed design of the initial prototype of SV-VM. Thirdly, to validate our concept and explain how we should improve it for public use, we will describe findings specific to SV-VM that we garnered from interviews with multiple experts: persons working for public commemorations each for the tsunami incident in Tohoku area in 2011 and the Hiroshima atomic bomb incident in 1945, persons working for a company running online portal sites related with funeral and cemetery, a president of a company for organizing online events on 3DCG based virtual reality environment, and the executive board members of a flower supplying and distribution company. Lastly, we will present several implications for designing online commemoration services with embodied rituals by discussing our findings from our design process and the expert interviews in a more general context.

1.1 Commemoration and Memorialization

From the Longman Dictionary of Contemporary English (6th Edition), *memorialize* means "to do something so that a person or event will be remembered by people," while *commemorate* means "to do something to show that you remember and respect someone important or an important event in the past." In this paper, we use the word memorialization especially for carrying out private rituals for the deceased (although it sometimes includes use in public situations), and commemoration for carrying out a public expression.

¹Please see our video as a supplemental material in the ACM Digital Library.

2 LITERATURE REVIEW

2.1 Online Commemoration

In the last a few years, commemoration practices on the web have been reported by researchers in multiple academic fields (e.g., [2, 17, 26, 30, 80]). Cann [17] reports how online memorial sites for victims killed by violent crimes have been rapidly adopted in the US, and claims that people are now shifting to adopting "virtual afterlives" enabled by online memorial services and Social Networking Services (SNS). Arnold et al. [2] investigate how people mourn, commemorate, and interact with the dead through digital media, reviewing existing digital memorial platforms with a series of case studies drawn from North America, Europe, and Australia.

Of particular note are SNS such as Facebook and Instagram, which allow people to utilize several services specialized for commemoration. Facebook provides "Memorialized Accounts" [22], a function that enables a particular user account belonging to the dead to be closed or changed to become an online memorial platform. (e.g., [13, 26, 30, 80]) On Facebook, a service called "Legacy Contact" has been released. With it, a living user can appoint another as a Legacy Contact who has responsibility to manage the account in case of his/her death. [13] These online memorials enable people to express their feelings with eulogy texts. However, there is no physical ritual such as lighting candles, burning incense, or offering flowers associated to this, as is common at graveyards or physical memorial locations.

Physical mourning rituals support bereaved people in their acceptance of the loss of their loved ones and in their recovery from grief [39, 63, 64]. Sas et al. [66] empirically surveyed the importance of embodied rituals for disposing digital remains in order to erase the negative feelings associated with loss through death or separation. Although online memorial functionality works for commemorating or expressing people's feelings for the deceased, there is lack of functionality supporting people's spiritual memorializations. Filling this space, we focus on utilizing recent interactive technologies supporting mourning, commemoration, and memorialization rituals.

2.2 Mourning and Memorialization Ritual Design in HCI

In the HCI design community, some researchers have investigated how interactive technologies contribute to bereavement, memorialization, and other rituals related to death. Massimi et al. [46] proposed the idea of "thanatosensitive design," design that engages with the many issues bound to mortality, dying, and death through the creation of interactive systems, and it is a critical emerging area for HCI research and practice. A range of previous works has explored issues such as the transfer of digital possessions belonging to the departed [14, 31, 32, 46, 49] support for grief [15, 45], and even potential issues for "death workers" in the post-mortem interval [49]. As an example of an interactive ritual designed for public commemoration, we refer to work by Hlubinka et al. [36]. They proposed a small altar named "AltarNation" which virtually connects users belonging to an online religious community with each other. Focusing on domestic memorialization ritual design, the first author of this paper Uriu and others proposed a digital family

shrine concept for people to remember deceased relatives [76] and an interactive altar with a candle flame called "ThanatoFenestra" for supporting ritual prayer for one's ancestors [77]. Applying and evolving its concept, Uriu and Odom [73] proposed an interactive altar called "Fenestra" and conducted deployment studies in domestic environments. They, and others, [75] are also trying to utilize incense smoke for memorialization practices. Wallace et al. [79] suggested digital locket jewelry that enables a digital legacy to be archived along with particular narratives about the deceased, and recently proposed a small photo viewer called "ReFind" [78] that brings up photos of the deceased based on newly taken photos.

While the domestic memorialization have been investigated as described above, some researches focus on installing technology into physical cemeteries. Gotved [28] surveyed QR codes on gravestones in Denmark and revealed how people have adopted a digital memorial culture provided through QR codes in cemeteries. These codes connect physical sites with virtual memories. There are also commercialized graveyards or columbaria utilizing QR codes for identification in Japan and Taiwan [72]. Along similar lines, Hakkila et al. have designed a location-aware navigation application at a graveyard [34], a dynamic gravestone, where different contents are triggered by inserting RFID equipped cards [33], and a virtual graveyard [35]. They have also made more general arguments regarding how pervasive displays could be installed in cemeteries and at memorial sites [38].

With the increase in practical design works, the theoretical framework for how HCI design and technology contribute to one's mourning and memorialization have been actively discussed. Moncur and Kirk [51] have suggested a framework for designing digital memorials. They articulated the need for future research to explore how interactive systems shape practices related to the post-self, how the identity of the departed is socially constructed. They [50] actually designed "Story Shell," an interactive sound player working with a sound-gathering system, which is specialized for archiving and playing back stories about the deceased. Odom et al. [56] modeled the design of future technologies aimed at supporting a relationship between the living and the dead, reviewing the process of their works Fenestra [73] and Timecard [55]. Pitsillides [61] proposed how to create new forms of agency for the dead by arranging the digital legacies that the deceased leave behind. In order to make digital legacies have agency or keep the deceased's presence in society, she pointed out how designers can combine digital legacies with physical and digital materialities such as ThanatoFenestra [77], Story Shell [50], digital locket [79], etc.

In Japan, the region of this study, some technology mediated memorialization services have been commercialized in the last decade. New style columbaria known-as Automatic Conveyor-belt Columbaria (ACC) located in urbanized areas of Japan adopt digital displays of photos and other information about the deceased [74]. Several smartphone applications for graveyard navigation are on the market (e.g., [57]). Gould et al. [29] described contemporary secularization of domestic memorialization rituals in Japan and introduce some digitalized Buddhist home altar (*butsudan*) examples. Uriu et al. [72] also reported recent adoptions of digital technologies in memorial practices in both Taiwan and Japan. As an example of a commercial product sold in Japan, we refer to work by Asukanet [4], which released a small domestic altar displaying a photo of the



Figure 3: Floral tributes in a cemetery or columbarium, in Paris, Montpelier, Melbourne, and Kamloops (from left to right).

deceased in the air [3] triggered by an *orin* (Japanese Buddhist bell). Although these recent products have not been adopted widely in all the country yet, at least, we note that their existence has been picked up by popular media.

2.3 Social Virtual Communities and Embodied Interactions for Connecting within VR

As related work to our design direction, constructing a virtual commemoration space online for floral tribute ritual, we present several examples of research on VR communities that have rapidly expanded in recent years. Since the emergence of Second Life at the beginning of the 21st Century, the concept of online virtual worlds created by CG has been widely known [11]. Although Second Life's initial strong impact on society had almost ended by 2011, its virtual communities were utilized in several specific ways, including education [25] and research [24]. Several behavioral science researches revealed Second Life users' identities as virtual avatars may have an effect on their real life performances and disclosures [37, 47].

Since relatively cheap head mount displays (HMDs) (e.g., Oculus Rift, HTC Vive, PlayStation VR, and others) have been commercialized, several VR communities are attracting users. Perry [60] predicts Social VR [5] will spread as widely as some other social media sooner rather than later, though it is currently predominantly used for gaming. McVeigh-Schultz et al. [48] surveyed how the providers and creators of VR communities (Rec Room, High Fidelity, VRChat, Mozilla Hubs, Altspace VR, AnyLand, and Facebook Spaces) encourage pro-social behaviors in their communities. They revealed that they develop embodied actions (e.g., facial expression, body or hand gestures, and other ways) to serve in new embodied communication rituals in VR; providing communicative affordances and social mechanics, and preventing harassment.

Research enhancing such embodied communication rituals in VR has been conducted in recent years. For example, researchers have developed handheld devices giving users a sense of force, weight, or haptics (e.g., [19, 43, 67]), and have enhanced experience in the real world with mixed reality approaches such as tele-conferencing [40], eating [53, 54], drawing [82], etc.

We believe our basic concept, online virtual memorial in VR integrated with embodied ritual, can be adopted by society, because of VR communities' increasing social presence. However, we have to argue how the specific design requirements for our concept will be constructed in a VR community. This is because the issue is an intersection between the nature of sensitivity in death related issues [46] and the unique but not fixed communications emerging in VR communities [48].

2.4 Bridging Embodied Ritual with Online Memorial in VR

This research integrates the domestic memorialization ritual (e.g., [56, 61, 73, 75, 77]) with the public online memorial (e.g., [13, 26, 30, 80]), providing VR communities (e.g., [48, 60]) and interactive techniques connecting a real object with the virtual world. Embodied rituals such as [73, 75, 77] support the personal spiritual feelings of the deceased and contribute to alleviating grief [66]. Meanwhile, public online memorials enable people to commemorate the deceased, and express and share their feelings of mourning and remembrance with others online. This research provides a solution for both spiritual memorialization and commemoration practices in public. As a research through design [81] case study, we reflect past findings from the existing literature in our design concept, developed an original system (SV-VM), and conducted interviews with some experts to validate the concept. Taking the above three sources of information as data, we broadly argue how HCI technology contributes to public memorialization and commemoration, and also propose some implications of creating an online VR community for this purpose.

3 DESIGN

3.1 Concept Design

We (designers) have encountered the need for commemoration of those who have died. In scenes reported by mass media, flowers are often offered at commemoration sites (e.g., [10, 71]). Considering these social aspects, we applied the floral tribute custom as one of the key concepts of this design project. In addition, our subjective experience from field work also inspired us to clarify our concept (See, Figure 3). As a well known example, the 9/11 memorial holds a name-reading ceremony where visitors may put flowers on a victim's name engraved on the stone [42]. Floral tribute is the most popular ritual for commemoration and memorialization around the world.²

On the other hand, we also noticed that floral tributes can be inconvenient in public spaces such as on the roads (e.g., [8]). In a recent case in Japan, it was reported that people living near Kyoto Animation Co. asked for a memorial monument for victims killed in an arson attack on the company building not to be constructed, because it, welcoming many mourners, could disturb the neighborhood's tranquility [44]. These phenomena gave us the idea of constructing memorials in the VR world instead of at real floral tribute sites. In addition, we think the virtual memorial should be

²There are exceptions in the world, depending on culture, region, religion, etc. For example, Jewish does not traditionally put flowers on a grave [52].



Figure 4: Patterns of flowers placed into SenseVase and Virtual Memorials (Left to Right): 1) roses, 2) daisies, 3) various flowers



Figure 5: The sequence of events (Left to Right). 1) real flowers are put into the SenseVase, 2) virtual flowers (already on the ground) move toward the periphery, 3) a space is made surrounding the memorial for new flowers which descend from the sky, 4) the flowers are rearranged around the memorial.

connected with the real world, because we believe that the bereaved want to physically offer flowers, as implied by the social phenomena we described above.

Digital technologies are bridging real memorialization sites with virtual (online) ones. Online memorial sites are common in several countries (e.g., [2, 17, 26, 30, 80]). For example in the US, a physical commemoration site for the Sandy Hook Elementary School shooting in 2012 was originally constructed near the place where the incident happened, yet was closed after just two weeks, and has been completely moved to an online sites [17, 62].

Despite this recent practice of moving physical commemorations into a virtual space, we only found a concept [36] for a design for public commemoration, in the HCI design community. In comparison, several works existed in the domain of domestic memorialization. These utilize unique materials such as candle fire [73], incense smoke [75], and sound [4, 50]. Referring to them, we would like to contribute to the area of public memorialization practices with interactive technology like those used in the domestic memorializations mentioned above. Hence, we decided to develop a way of interactively detecting floral tribute for an embodied interface for memorialization.

As we already described in the Introduction, our current design concept is described in the accompanying video. In the following subsections, we describe parts of our concept that have and have not been experimentally implemented in the working prototype. Thus, in this paper, we do not argue for or validate the technical implementation we are currently considering. However, some of the interviewees who were consulted in the Expert Interview section were interested in the practical details of how we intended to implement SV-VM. In such cases, we orally explained our plan based on what we describe in this section.

3.2 Overview of Interaction

"SenseVase with Virtual Memorial" (SV-VM) provides a domestic experience in which one can create a floral tribute for the dead. Functionally, it consists of an interactive flower vase (SenseVase) and a Virtual Memorial drawn by CG, as shown in Figure 4. Figure 5 briefly illustrates an example of how a mourner conducts a floral tribute ritual in a Virtual Memorial with SV-VM.

- 1) There are many flowers surrounding a memorial (a transparent ball in this case), which have already been offered by other mourners connected online. A mourner is putting flowers inside the vase.
- After the flowers are put inside, the existing flowers are moving toward the periphery and an open space is prepared around the monument.
- 3) Then, new flowers are fall from the sky.
- 4) The new flowers are placed in the open space.

Since SV-VM is designed for public commemoration and many mourners online may simultaneously offer flowers, we came up with these sequential movements: whenever you offer new flowers, you can recognize the CG flowers you are offering. We present the

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Figure 6: Examples of monuments. Left to right: a glass ball, a circular cylinder with words, and a cherry blossom tree.

current design prototype as an example of coordinating Virtual Memorial where multiple persons commemorate the deceased. We hope that creators may give Virtual Memorials different visual and interaction designs, referring to the current SV-VM.

As an initial conceptual prototype, we experimentally designed basic monuments and environmental settings. Figure 6 shows examples of basic monuments. As already mentioned, we do not want to add explanatory functions to the monument. Rather we think it should not have particular meaning and simply represent the center of the memorial. We came up with these ideas from our field work. The glass ball represents *nothing*, yet might seem like the deceased's spirit, which is derived from a design model, as shown in Figure 7 Left. The circular cylinder with the words "Rest in Peace" engraved is one of the simplest and most primitive shapes. Cherry blossom trees have recently been adopted in tree burial cemeteries in Japan [12] (Figure 7 Right).



Figure 7: Left: A public columbarium managed by Osaka city, Japan; Right: A tree burial site in Machida city, Japan

Figure 9 illustrates the technical overview of the SV-VM system. In the current prototype, only the local features (bottom part) are implemented, and our video prototype illustrated interactions by a single mourner. Signals from SenseVase are sent to a computer via serial communication. The messages are then forwarded via OSC communication by an OpenFrameworks-based application, to Virtual Memorial, which is made with Unity. When Virtual Memorial receives a signal, it visualizes a new set of virtual flowers at the memorial. Though we have not fully implemented SV-VM yet, it is possible to make SV-VM into an online application for collaborative flower offering. To allow multiple mourners to visit the same monument or switch between memorial connected to one's SenseVase, online servers will be required as shown in Figure 9. Once server side software is implemented, SV-VM system will be able to store the user's configuration, acquired from smartphones, or any SenseVase's latest flower status. Next, we will describe the design details of SenseVase and Virtual Memorial respectively.

3.3 SenseVase

Our flower vase, "SenseVase" consists of two parts: a glass container (sold as a commercial flower vase) and a bottom part specially designed by ourselves. In the bottom part, as shown in Figure 8 (A), there is a sensor unit and an Arduino circuit. The sensor unit is a kind of photointerrupter (combining infrared LEDs and phototransistors with resisters) specially configured for detecting water, flowers, and the glass bottom. The bottom part is specially designed to fit to the bottom of the glass vase, and is produced by 3D printer. The sensor unit detects if flowers and water are put into the vase. It can also detect how many flowers are put inside, as shown in Figure 8 (B)&(C), according to the raw data from the sensors, but cannot currently detect if nothing is inside or if only water is inside.



Figure 8: (A) Basic structure of a flower vase. (B) A few flowers and water inside a vase. (C) Many flowers and water inside a vase.

3.4 Virtual Memorial

Virtual Memorial, fully designed using 3DCG, visually expresses memorial monuments and flowers which are connected to SenseVase. Existing online memorials such as Facebook Memorialized Accounts [22] provide functions for visitors to leave text for the deceased, while physical memorials offer the opportunity for mourners to conduct physical rituals, including floral tribute. We strongly focused on drawing an interactive connection between the action of putting flowers into a vase and an expression of virtual flowers decorating the memorial, as shown in Figure 5 instead of any linguistic



Figure 9: The SV-VM system consists of online services (upper) and local devices (lower).

expression. Our Virtual Memorial does not offer any functions for mourners to leave text and does not present the mourner's name. We do not want to design a place for expressing the mourners' presence. This is one way in which our approach differs from existing SNS, on which many people are eager to collect "likes" from others.

As shown in Figure 10, the smartphone application for Virtual Memorial consists of several interfaces for users to interact with: 1) an interface for creating a new memorial monument (memorial owners), 2) an interface for choosing a memorial to visit (for mourners), 3) an interface for offering flowers to the monument chosen (for owners/mourners). While the owners are exclusively allowed to modify the configuration from this page, the mourners may only visit the monument they want to offer flowers to.

- When creating a memorial, an owner should be able to choose a monument and environmental settings from a gallery prepared by the service provider. It is also supposed that owners may be able to ask a CG creator to design and build a custom memorial in the future. The owner of the memorial must also decide the possible flowers that mourners may offer (Figure 10 Left).
- Mourners should be able to choose a memorial they wish to visit from a selection of existing memorials (Figure 10 Center).
- 3) After visiting the memorial, the mourner should be able to choose from a set of flower(s) to offer. If the owner has configured the memorial to allow mourners to freely choose flower(s), the mourner may select any combination they wish. In contrast, if only a limited set of flowers are set to be allowed (e.g., Figure 4: 1 & 2; Figure 10: Left & Right), the mourners have to adhere to rules, much like how one must keep to a dress code at a party.

4 EXPERT INTERVIEWS

In order to validate the current SV-VM design concept and gain insight into how we could update the design in the future, we conducted interviews with several experts working in the areas of physical public commemoration, virtual commemoration, online service related with mourning and memorialization, virtual reality based communities, and floral sales and distribution. These interviews were conducted as part of the design processes to gather



Figure 10: Screenshots of the smartphone application. Left: when creating a virtual memorial, the organizer sets what kind of flower(s) mourners may offer. Center: list of existing virtual memorials. Right: details of the selected memorial with a preview of the monument and its description.

feedback on the current state of SV-VM. As we mentioned, we created this concept by synthesizing knowledge from the literature review and our fieldwork. Thus, our goal was to receive broad opinions from interviewees to inform further developments. In fact, we received a diverse range of opinions from these interviews which include not only positive opinions and suggestions to revise our concept, but also many negative and critical ones. The experts were able to point out many issues with our concept that needed to be resolved before updating our concept to be available for the public.

All interviews were conducted during August to September, 2020 in Japan. Almost all interviewees were with Japanese people. As such, their sense of ethics are regional and our findings cannot be generalized to be a global perspective on our system and related topics, which is a limitation of this study. However, Japan—despite being a tiny island—is the only county that has been subject to the use of the atomic bombs in 1945 and faces many natural disasters almost every year, including catastrophic ones like the *tsunami* incident in 2011. Therefore, despite the highly limited number and demographic of the interviewees, we believe that our findings from

Table 1: Overview of interviews, interviewees, and respective purposes

Interview	I-1: President of a VR event produc- ing company	I-2: Person working on memorials for the <i>tsunami</i> incident in 2011	I-3: Person working on memorials for the Hiroshima incident in 1945	I-4: Workers of a company organiz- ing portal sites for memorial services	I-5: Executive members of a floral distribution and sales company
Interviewees and their expertises	P1-1: President of a company pro- ducing virtual reality (VR) events on its online platform. In each event, the company prepares a virtual environ- ment or stage using 3DCG, and users participate as avatars.	P2-1: Municipal staff member work- ing at one of the municipalities dam- aged by the tsunami of the Great East Japan Earthquake of 2011. He is now in charge of managing monuments and memorial sites dedicated to the disaster victims.	P3-1 : The chairman of a company located in Hiroshima. He is also an activist promoting commemora- tion to the atomic bomb victims. He is one of the organizers of the an- nual lantern floating festival, which was held online recently, due to the spread of COVID-19.	P4-1: Content creator on inheri- tance, P4-2: Designer, P4-3: Secre- tary to the chairman, P4-4: Support- ing temples (Chinese), P4-5 Con- tent creator on real estate and in- surance, P4-6: General affairs, P4- 7: "Farewell party" producer, P4-8 & P4-9: Web manager for cemeteries	P5-1 : The president of the com- pany, P5-2 : The executive adviser (prior president), P5-3 : Electronic commerce (EC) and online branding manager, P5-4 : Sales manager, P5-5 : Marketing strategy manager
Purpose	To consult a startup president on our concept's technical feasibility in as- suming the actual launch of a service in the future.	To get comments from municipal staff who manages the public memo- rial on behalf of the bereaved fami- lies.	To consult an expert on public memorialization in the Hiroshima area on how people mourn wartime victims.	To seek advice on recent trends in the memorial business and on oper- ating online sites for mourners.	To ask for comments from a com- pany specialized in distributing and selling flowers regarding virtualiza- tion of mourners' flowers.

these interviews include many insights and can lead to implications for integrating HCI technology into social commemoration practices in the future.

4.1 Methods

To find important themes of discussion or topics related with our future developments and online commemoration ritual designs in general, we combined common, structured questions and free discussion. The former allowed us to profile the interviewees and the latter led to the discussion of important themes. In detail, we adopted a semi-structured interview format, combining common questions we prepared for all interviewees and free conversations which were different between interviews. The common questions are divided into questions on personal background and feedback regarding our design concept. The former consists of three questions: 1) What is your business or activity?, 2) Do you have activities related with mourning, memorialization, commemoration, etc.? (especially related with floral tribute if you have), 3) Do you have activities related with online services or social networking services? After these questions, we showed the interviewees our concept video, and moved on to the latter questions: 1) Please let us know if you have any questions regarding the video, especially regarding unclear functions, 2) Would you like to introduce SV-VM to your clients or people you know well, if it could be released on public and used in the society?, 3) What are some good and bad points of particular functions in SV-VM?, 4) Are you interested in proactively using SV-VM or similar systems in your business?

All interviews were remotely conducted and recorded on Zoom. Each interview took, on average, one hour. All interview recordings were transcripted into Japanese: the language originally used in all interviews. The findings described in this paper are generated by the authors after analyzing and organizing these texts, and translating some parts into English. To analyze the interviews, we subjectively picked up comments from interviewees that were relevant to revising the SV-VM design, the future of commemoration and memorialization in general, and other opinions leading to thoughtful discussions. We did not adopt any coding method in this analysis, as we did not aim to find major and frequent opinions or keywords, nor evaluate the current concept. This research, based on these interviews, has been ethically approved by the University of Tokyo.

4.2 Interviewees

We conducted a total of five interview sessions [I1-5] with a total of 17 interviewees (See, Table 1). While we (the two interviewers) interviewed one person in I1-3, multiple interviewees joined in I4-5. In this paper, P1-5 refers to the interviewees in I1-5. Most interviewees or participants were recruited through the authors' social connections (P1, P3, and P5). P2 and P4, however, were contacted via a contact form posted on the web.

The interviewee selection process was relevant to leading to our themes of discussion. We chose to interview people from professional backgrounds with a range of proximities to memorialization (i.e., VR technology [I-1], memorialization industry [I-4], and the floral business [I-5]), which are highly related with SV-VM design concept. The temporal proximity of the incident they were involved in memorializing (i.e., the *Tohoku tsunami* disaster [I-2], and the Hiroshima atomic bomb incident [I-3]) was another factor we considered. We initially planned to interview with stakeholders of incidents that recently happened (e.g., [70, 71]). However, we noticed it is difficult for bereaved families who recently (in the last 10 years) lost their loved ones to accept our current concept by receiving opinions from I-2. Therefore, we shifted our focus and found an interviewee for I-3 who knew Hiroshima's situations, an incident where 75 years have already passed.

Interview 1 [I-1]. P1 is the president of a company producing virtual reality (VR) events that are conducted online. In each event, the company prepares a virtual environment or stage created using 3DCG, and users participate as avatars. We invited him as an expert in online VR community development with hopes of that we could consult him on the technical feasibility of our concept given that we wanted to deploy it as a real service in the future.

Interview 2 [I-2]. P2 is a municipal staff member working at one of the municipalities damaged by the *tsunami* of the Great East Japan Earthquake of 2011. He is now in charge of managing monuments and memorial sites dedicated to the disaster victims. This includes managing floral tribute practices and preserving earthquake remains, such as architecture that was damaged by the earthquake. We invited him as an expert in administrating physical memorials and a holder of knowledge on bereaved family's thoughts.

Interview 3 [I-3]. P3 is the chairman of a company located in Hiroshima. He is an activist promoting commemoration to the atomic bomb victims. While his company's main business is car sales, it has a building next to the Hiroshima memorial park (Figure 2) and

he has arranged his building's roof terrace to be a place where people can see how the people who survived the atomic bomb and reconstructed the city and their posterity are living while praying for peace. On August 6th, 2020, he contributed to an online commemoration event [58] as one of the organizing members. We initially invited him as an expert on public memorialization in the Hiroshima area. We were introduced to him by a mutual acquaintance from Hiroshima. However, we noticed that he is also an expert on holding a digitally-mediated commemoration event which was highly similar to our SV-VM concept.

Interview 4 [1-4]. P4 consists of nine persons working at a company producing and organizing web-based information portals for cemeteries, columbaria, Buddhist home altars [29, 68, 73], funerals, memorial events, and other services related with mourning and memorialization. We invited them as experts on recent trends in the memorial business and on operating online sites for mourners. The roles of each person was, P4-1: Content creator on inheritance, P4-2: Visual designer, P4-3: Secretary to the chairman, P4-4: Supporting temples (Chinese), P4-5 Content creator on real estate and insurance, P4-6: General affairs, P4-7: "Farewell party" producer, P4-8 and P4-9: Web managers for a cemetery. I-4 was conducted with all members of this group and had all participants gathered in the same Zoom room.

Interview 5 [1-5]. P5 consists of five persons from a company specialized in distributing and selling flowers. The members consisted of P5-1: the president, P5-2: the executive adviser (prior president), P5-3: electronic commerce (EC) and online branding manager, P5-4: sales manager, and P5-5: marketing strategy manager. The company has deals with a huge number of flower shops and have recently begun to make a sales to individual customers via their EC services. Their service fulfills a variety of needs and customers use them for many different purposes. Some examples include personal (domestic) use, gift, wedding or celebrating events, and death rituals. They are also interested in smart technology, such as creating services integrating with mobile and online services, and have even applied for a patent on flower vases with embedded sensors. I-5 was also conducted in a group with all participants gathered in a single Zoom room.

5 SPECIFIC FINDINGS RELATED TO SV-VM

We received several opinions and suggestions from the interviewees. In this section, we describe feedback we received regarding the current state of SV-VM. We also detail how the interviewees interpreted the concept behind SV-VM and its specific functions.

5.1 Positive Feedback and Interpretations

5.1.1 The Value of a Smart Flower Vase. From the perspective of exploring new floral business opportunities, P5 were highly interested in the SV-VM concept, especially about SenseVase. They were actually planning to produce various smart vases, though they did not have a product out at the time. They may have been motivated by the difficulties they were facing selling flowers. Due to the COVID-19 pandemic, every in-person ceremony—usually decorated with many flowers such as funeral and wedding—had reduced physical attendance (and thus reduced flower purchases).

P5-1 suggested that a smart flower vase could be applied to a wider set of ceremonies than just memorialization: "It might be good to place the vase on the table for ceremonial parties, such as wedding parties. For example, for a wedding, we could cooperate with high-quality food delivery services to deliver food and a vase with fresh flowers to each family. The participants then offer their flowers to decorate not only their party table but also the wedding hall with projected flowers. As more remote participants offer flowers, more flowers would be projected on the walls. They can all, then, appreciate flowers, have good food, and hear the celebrating messages."

They were also interested in the direction of linking the vase to a sense of Telepresence. P5-1 argued that it was important that the smart flower vase is present at home as a communication hub: Similar to OQTA [59], the system with which a person pushes the button on the smartphone and a dove clock will sound in remote, I suppose that the flower vase could produce flowers when somebody sent flowers via the Internet. This is compelling to users even if they were sent virtual flowers. It is similar to the 'Like' function on Facebook. I would prefer that, when the bereaved family opened their Virtual Memorial, they see flowers delivered in response to others' actions and they recognize that many people care about the deceased and them.

One specific feature P5 requested was for the SenseVase to scientifically monitor the fresh flowers' condition. "As another idea, I would like to have a function where it could detect the condition of flowers or even water inside the vase." P5-5 also mentioned: "I would appreciate if the flowers are drawn as dynamic pictures, displaying withered flowers as time passes, compared to when new flowers are initially put into the vase." Since P5 were aware of various situations in which flowers are employed, they provided the most input out of all the interviewees regarding additional features they wanted in future versions of SenseVase.

5.1.2 The Multi Purpose Home Altar. Though we initially designed SV-VM for public commemoration, some of the interviewees suggested using it in private commemorations (despite our video only showing a public commemoration scenario). In I-4, some of P4 interpreted SV-VM as an artifact for domestic memorialization, likening it to the Buddhist home altar practices that traditionally existing in Japan [29, 68, 73]. P4-1 said: "I want to know how the mourners might use it in particular situations. Which scenarios do you suppose they might use it in? When an incident happens, will people buy a vase and do a floral tribute? Or will my family buy a vase after I die?" As an answer to his question, we told him that we had not thought of concrete scenarios yet, and either situations could be possible. Then, P4-3 mentioned: "I suppose that I could have a Buddhist altar for memorializing not only my lost family members and ancestors but also other people, who I could change flexibly. For example, my grand parents (on the maternal side³) or victims of disasters?" P4-5 also proposed that SV-VM could be used to support existing online memorials: "There are a lot of web pages left by owners who already passed away. It (SV-VM) could be used to support performing floral tribute to these sites, enabling a kind of 'online gravesite visiting.'

People in Japan share a common image of domestic memorialization practices centered on the Buddhist home altar, despite this

³A family's Buddhist home altar is usually handed down to the eldest son, and a married women belongs to her husband's family according to Japanese customs. Therefore, a person's maternal side relatives are not included in the family alter as the ancestors.

practice having gradually faded in recent decades. Therefore, SV-VM may be interpreted as a new artifact for performing domestic memorialization customs or rituals.

5.1.3 Flower Settings for Memorials. From real experience of organizing floral tribute ceremonies, P2 agreed with the function of allowing the owner to set the kinds of flower(s) that the mourners can use to pay tribute. Referring to how his colleagues prepared a ceremony at the public event, he mentioned: "At the official memorial services organized by the city or prefecture, the organizers prepare white flowers that all mourners need to use. All mourners were required to offer the white flowers. Meanwhile, various kinds of flowers were offered at a relatively small memorial voluntary prepared by the bereaved families. I saw a memorial on which there were only white flowers on the left side and a memorial with colorful ones on the right." Despite this being the only opinion that we received regarding the ability to restrict the kind(s) of flowers that can be offered, this opinion suggests that the function has value, since it is adopted in the existing floral tribute ritual.

5.1.4 Substitution of Physical Sites. P1 positively interpreted our concept as a solution that might substitute physical memorials after finding similarities with works his company was recently involved in. He said: "There is a need to virtually preserve buildings or rooms before they are demolished. This direction overlaps with the concept of giving virtual floral tributes. The cost of organizing and maintaining a floral tribute at a real site is very high, and mourners are required to physically visit the site. I agree that it will likely be done virtually in the future."

5.2 Story, Narrative, and Sense of Achievement

While we received positive opinions regarding SV-VM as described above, the interviewees brought to our attention critical design issues that need to be considered or revised in the future development. In particular, they pointed out the lack of stories explaining the background of each memorial and any personal narratives in SV-VM. They commented that such stories would be essential for involving users in the commemoration practices, and providing a reason for mourners to participate in giving floral tributes. For example, P3 claimed: "Though the owner has some options to customize a memorial, there appears to be no reason for the mourners to actively want to join the floral tribute. While the visualization of flowers provides a beautiful illustration, there is the lacking of the sense of self achievement for the mourners." Furthermore, he concretely proposed that SV-VM should have a function where the mourners can trace their actions of commemoration: "In feedback regarding the online lantern event, some mourners said 'I cannot see my message.' I think that a function where mourners can trace their messages later is very desirable. The mourner will never be satisfied with just offering flowers with condolences." Meanwhile, P1 also claimed: "I think that nobody is interested in having complete strangers send flowers to them. If it (SV-VM) is to encourage people to become emotionally involved with the bereaved, organizers will need to be provided with a function to write stories about each memorial."

In addition to the story issue, P1 also pointed out that there is a lack in the sense of achievement experienced when using SV-VM. He questioned how mourners using SV-VM would really feel when

doing a floral tribute by themselves: "I doubt that the 3D effect shown when flowers are put in the vase will effectively work to make the mourners feel that they have put their feeling into the action. Perhaps, a richer expression is required."

Another view on the subject was given by P4-4, who argued that there was a difference between common and famous people: "There are two types of people commemorations are dedicated to: family, relatives, close friends, etc.; and famous persons such as singers and politicians. I think that the SV-VM is too easy or casual for private mourners mourning the former. Many of mourners emphasize the importance of physically offering flowers or visiting the grave sites of people close to them. However, I feel that SV-VM may soon be accepted for the latter, since their stories are well known in society and it is better for mourners to easily visit and commemorate them on the web." We totally agree with the importance of designing stories for users to engage them commemoration practices and providing functions for them to share their own narratives with others. We note that the story and narrative can also lead to the sense of achievement, which can foster a sense of involvement and provide motivation for actively participating in commemoration practices.

5.3 Incentives for Mourners and Owners

Looking from the other side, P5-4 pointed out that there may be a lack of incentive for those receiving the flowers as well: "*The physical flowers remain with the person who holds a floral tribute. But, only the pictures remains for the person who is receiving the flowers through SV-VM. Do you have an idea for how physical flowers might be delivered to the recipients as well?*" P5-4 additionally said: *In case of wedding, the bridal couple will likely not be happy seeing only illustrated flowers while the remote participants have the feeling of achievement.*

talked about designing incentives for the mourners, by introducing a traditional custom from her hometown (*Okinawa*): "We have the event called '<u>Shīmi</u>.'⁴ During this event, we visit our family tomb, clean it, and have an all-night drinking party there. This floral tribute may be widely accepted if it could have an incentive in addition to allowing the mourners to be personally satisfied with their flower offerings."

As an owner of a memorial, P3 emphasized the importance of producing the experience of participation: "In addition to the stories and narratives, you must consider how a sense and feeling of participation can be induced in the mourners. In our case, we did not only visualize the lanterns with the messages sent from all over the world on the web. We also placed five large screens in the park next to the atomic bomb dome (Figure 2 Left), and arranged them to show lanterns as if they were flowing on a river. It was very important for the participants to see their actions being reflected in the real world."

Through the interviews, we received many suggestions regarding how we could update SV-VM to be accessible to the public and to be accepted into society. We noticed that there was great importance in considering each stakeholder's feelings, the story behind the memorial (for motivating participation in the commemoration), the sense of achievement, and incentive design for making participants want to join the service.

⁴This is similar to the Ching-Ming Festival in Chinese culture.

6 GENERAL FINDINGS AND DISCUSSIONS, AND IMPLICATIONS FOR DESIGN

In this section, we provide a general discussion on how HCI technology will contribute to people's memorialization and commemoration practices, and present several implications for designing online memorials in the future. The discussions and implications are synthesized from reviewing the literature, our findings during the design process of SV-VM, and our findings from the interviews we held. Each subsection below corresponds to a major implication we synthesized.

6.1 The Bereaved's Feelings

Through the interviews, we learned of the complex feelings surrounding memorialization and the numerous factors at play. In this section, we summarize our main findings regarding how the bereaved might feel towards public commemoration in general.

6.1.1 Time Dependence of Feelings Towards Commemoration. One of our major findings was that commemoration practices are not always welcomed by the bereaved people. Furthermore, we found that their attitude towards commemoration practices is especially dependent on how many years have elapsed since a disaster or an incident. P3, representing people in Hiroshima, strongly agreed with our concept as he had experienced success in running a similar event, "Online Floating Lantern," on August 6th, 2020 [58]. He said: "When I received this interview offer, I thought that you planned it (SV-VM) after being inspired by our activities! Surprisingly, nobody denied or complained about our event. There were comments such as 'this is a good idea fitting to this age,' and 'what an amazing challenge this is!'' In contrast, P2-who knows the feelings of bereaved persons who lost their loved ones in the earthquake and the tsunami on March 11, 2011-mentioned negative opinions that might come from the bereaved families living near the memorial site. He said: "I think that it is not the time for us to accept your concept yet. We decided to bring down some buildings that were damaged by the tsunami but still standing. Today, sightseers are visiting these places in large buses, sometimes loudly taking commemorative pictures. Some of bereaved people are deeply distressed by the phenomenon. I cannot introduce it to them, saying 'here is the (online) floral tribute site where many people can easily and casually visit."" It took 75 years since the atomic bomb in Hiroshima for people, including the atomic bomb survivors, to completely recover the city. Today, almost nobody doubts that people all over the world would want to commemorate the victims and pray for peace. Meanwhile, it has only been a decade since the great Tohoku earthquake and many bereaved are still filled with grief and struggling to recover their everyday lives. There is a strong contrast in both acceptance of our concept as well as the state of the people who suffered from each calamity.

6.1.2 Major Reasons for Negative Feelings. Some research articles describe that people living near the heritages of death and bereaved people suffer from similar situations; sites that remind the locals of pain turn into unwelcome tourist destinations [7, 23]. Through the interviews we conducted, we were made to recognize that we have to consider how the bereaved people feel about the existence of a public commemoration site, even if it only exists as an online service. Through the interview, P2 brought to our attention that

many of bereaved people are opposed to preserving the remnants of the disaster. Some of the bereaved people claim that the local government should use public money to support the lives of the living instead of spending money on preserving the remains of the destroyed. Others appealed to the local government not to preserve the sites because the sight of the remains brought up traumatic memories. To further clarify that preservation and memorialization were not the foremost concern of the bereaved peoples, P2 told us that, when one of his colleagues held a meeting to explain plans for preserving the neighborhood remains, a person said "Please do not make a digital floral tribute site!" P4-1 gave a similarly negative, but different opinion: "I cannot recommend it (SV-VM) to our customers, because I can imagine that the bereaved would not want to see the flower offerings gradually disappear as less mourners visit the site. I have also heard that bereaved people usually interpret the physical site where an incident happened as the place where the bereaved's minds exist. Therefore, I think it would be difficult for them to accept a virtual site in the same way they would a physical site." Despite the limited number of opinions we received, we can infer that there is a need to carefully consider how each stakeholder is related to a memorial site and how they interpret it, even when the site is virtually created online.

6.2 Monetizing and Branding

6.2.1 Who will Pay for Death Rituals. Some of interviewees expressed their concerns with deploying, monetizing, or commercializing death rituals that included the online memorial. P3 introduced a story of when he tried to collect monetary support via a crowdfunding service for his Online Lantern project: "We needed a significant amount of money to rent large displays and a place in the park, so we wanted to openly call for support via crowdfunding. However, some of people related with the event were opposed to this because there was a strong opinion that the charities should not make profits. In particular, they pointed out a problem: the crowdfunding companies gain the profit from the collected funds as part of their business. Eventually, I personally paid for almost all for the costs, with the exception of the parts which were paid using limited donations from just a few organizations." The issue of finding appropriate funding for memorialization was echoed by P2, who is involved with people both supporting and opposing the preservation of the remains of residential buildings damaged by the earthquake and the tsunami in 2011: "We are now constructing a public memorial site. But, the people opposed to the idea expect us to not use public money for it. We are always careful when progressing the project and make sure to hear both opinions."

6.2.2 Co-existing with the brand of death rituals. Thinking of how P1 might begin a service related to death rituals, he talked about the risk of having the new service co-exist with his company's existing brand image: "The users joining the virtual events we produce mostly come from the gaming communities, which means they are coming to enjoy the events as a new form of entertainment. Therefore, I would hesitate to begin a kind of online memorial service on our existing platform, especially if it meant involving the current customers in it." Similar to P1, P5 also referred the same issue of conflicting brand images. P5-3 mentioned: "We always pay careful attention whenever we do a promotion with keywords related to memorial

services or death rituals. It is easier to promote products for weddings than memorialization." In addition to this, P5-4 said: "It is common for local flower shops to have different brands; one for the death rituals, and another for all other occasions." There is no question that creating a memorial site or a product for any death ritual requires money, even if it exists online. However, these activities are sometimes not deemed to be the same as any other business in society.

6.3 Virtual/Online Rituals Overcoming Limitations in the Real World

Virtual memorialization sites, such as those made possible by SV-VM, can overcome geographical limitations. Obviously, there are limitations in physically constructing monuments for memorialization such as space or land, cost, maintainability, sustainability, and so on. In contrast, there are no limitations of space in the VR world. If SV-VM, and a properly designed memorial in VR could be released to the public, it will be a choice for people seeking a way of memorialization and commemoration. Most of the experts agreed with this concept, except P2 who cared strongly for bereaved people who are still living with strong grief and struggling to recover their everyday lives. We have to understand that his opinion demonstrates a limitation of all of online memorials.

As P1 mentioned, there is a need to preserve existing buildings or environments that will disappear in the near future and to allow lively visits to the location with other people rather than only reminiscing about memories of the past and old scenes. While this is possible in a virtual memorial, the current 3DCG based virtual communities are only used by a limited demographic, often limited younger people who play computer games. However, P1 also said that there is no technical limitation preventing them from realizing the Virtual Memorial with SenseVase. However, there are still the need to manage the service and produce hardware and these are expected to be more difficult than software development.

While, some of P4 demonstrated concrete cases in which virtual sites could resolve physical issues. P4-7 organizes "farewell parties," which are events for the bereaved family held after the formal funeral rites. She proposed the idea of using our concept at one of these parties. While recent Japanese funerals are typically only open to limited relatives who are close to the deceased (20-30 persons in average), the farewell parties sometimes invite more than one hundred people to casually commemorate the deceased. However, due to the COVID-19 pandemic, both funerals and farewell parties are inviting less participants than before. Therefore, P4-7 was seeking an alternative way of attending the parties and a ritual that can be conducted by the remote participants. She mentioned: "I want to introduce this service to my customers, if it could be used. In the farewell parties we organize, we have a floral tribute ceremony. Due to the COVID-19 situation, I believe that an interlocking systemcoupling the fresh flower offered with the visualization of virtual flowers-will resonate with the audience. I also love the feature that it (SV-VM) will eternally exist even after the party finishes." P4-9 also noted the need for remote memorialization: "There are people who want to visit their family grave sites but unable to do so. Instead of physically offering flowers, the deceased's portrait picture (iei [73]) could be projected on an electric paper put on the wall and be filled

with a lot of flowers. I would like to recommend this system to people like this. However, it may be difficult for users to understand who offered the flowers with the existing expression (on SV-VM) of the piled flowers." In addition to his comments, P4-3 introduced a feature of his family's grave site: "There is a kind of bulletin board at the site that notifies visitors of mourners of who visited recently. This works well as a communication tool for our relatives. A similar function could be integrated within it (SV-VM)."

6.4 Embodied Rituals for Memorialization or/and Commemoration

Though we initially designed SV-VM with public commemoration in mind, it can support both a single user's private memorialization rituals in the domestic environment and public commemorations via a virtual memorial. The former issue has been addressed by previous works (e.g., [51, 56, 61]) with some works approaching the issue using physical or embodied ritual designs [4, 50, 73, 75, 77, 79]. As expressed by P4-3, SV-VM may be useful in the domestic environment (as a multi-purpose Buddhist home altar in Japan). In contrast, the latter issue has been mainly handled by online memorials (e.g., [2, 17, 26, 30, 80]), and less touched upon in HCI research.

Some physical memorials have recently moved onto online memorial sites [17], but existing ones only enable visitors to commemorate or leave messages by text, and do not provide any embodied rituals. SV-VM provides an opportunity for embodied ritual for personal memorialization at home and for public commemoration.

As a *research product*, [56], that can be placed anywhere in a living environment, SenseVase can serve as a sacred artifact for memorialization when connected with and displaying Virtual Memorial. At all other times, it would look like a normal vase in the domestic environment. This approach of hiding sacred artifacts for embodied rituals in plain sight (i.e., in the everyday living space) was also argued in the previous work [73] that utilized candle fire as a trigger for memorialization practice.

However, some of the experts did not value the current embodied ritual design. They suggested that it was necessary to revise SV-VM and create some additional functions. Indeed, P3 emphasized the development of functions that allow mourners or participants to recognize that their own actions and engagements are being visibly displayed in public. He also highly recommended us to add functionality enabling of writing comments or messages. P1 questioned the current quality of the 3DCG expression where virtual flowers respond to physical flowers offered to SenseVase as shown in Figure 5. To support both the private memorialization and the public commemoration, these suggestions should be reflected on a revised version of SV-VM and can be applied for designing online memorial practice in general.

6.5 Metaphors of Everyday Objects

SV-VM adopts its design components, flowers and vases, from items that have multiple meanings and metaphors widely accepted in the world: things for decorating and floral tribute, and both for public and private situations. As a domestic artifact, SenseVase just looks like an ordinary vase. The flowers put into vases are also interpreted as one of the most popular colored living thing. On the other hand, floral tributes are made both at public and private memorials, as well as other applications proposed by the interviewees. For example, P5 suggested delivering flowers and a flower vase to people so they could send virtual tributes in real-time during an event. Though they had a wedding reception in mind when suggesting this, we believe the idea can be applied to remote funeral attendance services as well. P4-7 also proposed the idea of using SV-VM at their farewell party, and P4-9 suggested SV-VM could be used to remotely support domestic commemoration practices.

Integrating this feature of flowers and vases into an interactive system suggests a novel direction for how HCI technology can contribute to mourning and memorialization. Several previous approaches have utilized digital remains as icons or agency of the deceased with various designs (e.g.,[56, 61, 73, 75, 77]). SV-VM not only provides a way of following these existing approaches but also suggests a design approach that does not need to use personal digital remains.

The Virtual Memorial does not display any element directly representing the dead people/person, such as photos. SenseVase with flowers just performs as a domestic object, when a display device (e.g., monitor, projector, HMD, etc.) for Virtual Memorial is turned off. A methodological contribution of this papers is that it demonstrates a case of applying metaphors (sometimes found in HCI design research [1, 6, 18, 69]) found in everyday objects (flowers and vases in this work) for design [65] for memorialization.

Out of the experts we interviewed, only P4-9 proposed the idea of preparing the deceased's portrait and argued that is was necessary to have a personal icon or representation. The other experts accepted the design direction of not having a visible representation. At the same time, however, some of them claimed that the user experience would lack a sense of achievement and engagement. Specifically, they stated that users would lack a reason and story for participating in SV-VM.

Overall, we believe that, especially for public commemoration, icons directly representing the deceased are not necessary. Instead, a function or artifact like SenseVase—which motivates one to do commemoration rituals—could serve as a hub connecting everyday life to non-routine practices [73].

6.6 Pro-social Commemoration in VR Communities

As discussed for other social communities in VR [48], public commemoration communities have to be carefully administrated and kept pro-social. Is is known that administrators of commemoration sites sometimes struggle with managing visitors as sightseers or for dark/black tourism who sometimes offend the the bereaved [23]. If a public virtual memorial monument or community gets famous, it is possible that many offenders will visit the site and make trouble.

However, in the COVID-19 pandemic situation, virtual funerals have been conducted in online gamers' communities [20, 21]. These examples can be interpreted to mean that people in mature online communities can be united and provide a pro-social atmosphere. Furthermore, we believe that the embodied ritual (e.g., floral tributes), we propose in this paper, will achieve keeping online memorials civil. P3's online lantern's event in Hiroshima (which was actually less promoted than he mentioned) and its success have obviously validated that online commemoration can be conducted with the pro-social atmosphere.

We believe that our concept, an online memorial with embodied rituals, will be required by society, with the increase and maturation of VR communities around the world. However, how to keep it profitable, pro-social and wholesome will be continuously discussed in future research. However, as pointed out by P2, there will likely be a diverse range of opinions in the online communities regarding this. A place for commemoration practices always involves many different stakeholders and one must carefully consider the crossing point of people's emotions and spirituality when designing one.

6.7 Crossing of Emotion and Spirituality

Our research though design process of SV-VM provides an opportunity for researchers considering the complex of people's emotion and spirituality, which is always virtual and invisible. Strong emotions and spirituality are associated with the deceased all over the world. As such, it is sometimes hard for the bereaved to face the presence of the deceased through actions related to them such as attending the funeral, disposing of the corpse [41], visiting the graveyard, and even seeing his/her picture in everyday life [73]. While there is a spiritual wish to memorialize the deceased, some may have the feeling of not wanting to become emotional.

People's emotional and spiritual reactions regarding public commemorations are often more complicated than their reactions to personal memorialization practices. At the beginning of our design process, we focused on temporary commemoration sites (for floral tributes) that are physically removed after a time. However, after our interview with P2, we noticed there were many issues in our design that needed to be resolved to be considerate towards bereaved people who are still in grief. We sought to consult P3 about this as he was familiar with the situations in Hiroshima where it has been 75 year since the incident. From P3's interview and our own personal experience, we have not yet met any person having a negative opinion towards the commemoration rites held in Hiroshima. However, we must consider something P2 mentioned in his interview: "Even in Hiroshima, I think that there are people who do not like the public memorialization, even if the number is small." Thus, we must always consider the possibility of opposing opinions existing in the public.

After Bell [9] proposed the concept of "Techno-spiritual Practices" at Ubicomp 2006, many religious support applications have been commercialized, especially for smartphones, yet little research (including death related issues) has been conducted [16]. However, the amount of research on interaction designs and embodied rituals for the personal memorialization is gradually increasing (e.g., [38, 73, 78]), and the idea of online memorials is beginning to gain acceptance, especially in the West (e.g., [2, 17, 26]). Although SV-VM's concept has been partially validated through this research, we argue that designers creating an online memorial have to refer the pros and cons of the technologies described above, and take into consideration the many different opinions when designing a particular commemoration site.

The issue of monetization, commercialization, and promotion was also mentioned by the experts in this paper and represents another complex and difficult aspect of commemoration design. Though this is not related to the user experience, it is an aspect of design that we must take into consideration whenever designing for death rituals.

7 CONCLUSION

In this paper, we described SenseVase and Virtual Memorial (SV-VM), an integrated design concept intertwining a sensor-embedded vase with an online virtual memorial. To validate the concept of SV-VM, we conducted interviews with individuals who were experts in fields related to SV-VM. We articulated several implications for designing online memorials with embodied interaction based on our findings from the design process and the interviews. While most of the experts agreed with our concept of integrating online memorial with the interactive flower vase, some of them suggested that we revise SV-VM to support the mourners, the owners, and other stakeholders. We took particular notice of the possibility that there might be conflicting opinions about a memorial site, especially depending on how long it has been since an incident occurred. Indeed, we have to carefully recognize that there are many bereaved who do not prefer to have a public commemoration site. In the HCI community, digital rituals for personal memorialization with embodied interaction techniques have been sought and practically designed. Our research, which began with the design of SV-VM, responds to emerging needs for online public commemoration in the world. The design was developed while keeping in mind the importance of embodied interaction in supporting memorial practices.

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REFERENCES

- [1] Alissa N. Antle, Greg Corness, Saskia Bakker, Milena Droumeva, Elise van den Hoven, and Allen Bevans. 2009. Designing to Support Reasoned Imagination through Embodied Metaphor. In *Proceedings of the Seventh ACM Conference on Creativity and Cognition* (Berkeley, California, USA) (*C&C* '09). Association for Computing Machinery, New York, NY, USA, 275–284. https://doi.org/10.1145/ 1640233.1640275
- [2] Michael Arnold, Martin Gibbs, Tamara Kohn, James Meese, and Bjorn Nansen. 2017. Death and Digital Media. Routledge. 188 pages.
- [3] Asukanet Co., Ltd. 2019. ASKA3D. https://aska3d.com/en/
- [4] Asukanet Co., Ltd. 2019. Omokage. https://www.mds.ne.jp/omokage/
- [5] Jeremy N. Bailenson and Jim Blascovich. 2011. This is your mind online. IEEE Spectrum 48. 6 (June 2011), 78-83. https://doi.org/10.1109/MSPEC.2011.5779797
- [6] Saskia Bakker, Alissa N. Antle, and Elise van den Hoven. 2012. Embodied metaphors in tangible interaction design. *Personal and Ubiquitous Computing* 16, 4 (2012), 433–449.
- [7] Heidi Bauer-Clapp. 2017. [Review] Heritage of death: landscapes of emotion, memory and practice. *Heritage & Society* 10, 3 (2017), 287–290.
- [8] BBC NEWS. 2006. 'Dangerous' road tributes concern. http://news.bbc.co.uk/2/hi/ uk news/wales/4806870.stm Accessed: 2019-12-27.
- [9] Genevieve Bell. 2006. No More SMS From Jesus: Ubicomp, religion and technospiritual practices. Proc. of UbiComp 2006 (2006), 141–158.
- [10] Allison Blais and Lynn Rasic. 2011. A Place of Remembrance. National Geographic Books. 227 pages.
- [11] Tom Boellstorff. 2008. Coming of Age in Second Life: An Anthropologist Explores the Virtually Human. Princeton University Press, USA.
- [12] Sébastien Penmellen Boret. 2014. Japanese tree burial: Ecology, kinship and the culture of death. Routledge.
- [13] Jed R. Brubaker and Vanessa Callison-Burch. 2016. Legacy Contact: Designing and Implementing Post-mortem Stewardship at Facebook. Proceedings of the

2016 CHI Conference on Human Factors in Computing Systems CHI '16 (2016), 2908–2919.

- [14] Jed R. Brubaker, Lynn S. Dombrowski, Anita M. Gilbert, Nafiri Kusumakaulika, and Gillian R. Hayes. 2014. Stewarding a Legacy: Responsibilities and Relationships in the Management of Post-mortem Data. In Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems (CHI '14). ACM, Toronto, Ontario, Canada New York, NY, USA, 4157–4166.
- [15] Jed R. Brubaker and Gillian R. Hayes. 2011. "We Will Never Forget You [Online]": An Empirical Investigation of Post-mortem Myspace Comments. In Proceedings of the ACM 2011 Conference on Computer Supported Cooperative Work (Hangzhou, China) (CSCW '11). ACM, New York, NY, USA, 123–132. https://doi.org/10.1145/ 1958824.1958843
- [16] Elizabeth Buie and Mark Blythe. 2013. Spirituality: There's an App for That! (But Not a Lot of Research). In CHI '13 Extended Abstracts on Human Factors in Computing Systems (Paris, France) (CHI EA '13). Association for Computing Machinery, New York, NY, USA, 2315–2324. https://doi.org/10.1145/2468356. 2468754
- [17] Candi K. Cann. 2015. Virtual Afterlives: Grieving the Dead in the Twenty-First Century (Material Worlds Series). University Press of Kentucky. 212 pages.
- [18] Augusto Celentano, , and Emmanuel Dubois. 2015. Evaluating metaphor reification in tangible interfaces. *Journal on Multimodal User Interfaces* 9, 3 (2015), 231–252.
- [19] Inrak Choi, Eyal Ofek, Hrvoje Benko, Mike Sinclair, and Christian Holz. 2018. CLAW: A Multifunctional Handheld Haptic Controller for Grasping, Touching, and Triggering in Virtual Reality. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (Montreal QC, Canada) (CHI '18). ACM, New York, NY, USA, Article 654, 13 pages. https://doi.org/10.1145/3173574.3174228
- [20] Caitlin Doughty. 2020. EXPLORING GRIEF IN ANIMAL CROSSING: NEW HORIZONS. http://www.orderofthegooddeath.com/exploring-grief-in-animalcrossing-new-horizons Accessed: 2020-9-17.
- [21] Josh K. Elliott. 2020. 'Final Fantasy' gamers hold online funeral for player who died of COVID-19. https://globalnews.ca/news/6832247/coronavirus-video-gamefuneral/ Accessed: 2020-9-17.
- [22] Facebook. [n.d.]. About Memorialized Accounts, Facebook Help Center. https: //www.facebook.com/help/1017717331640041/ Accessed: 2021-1-5.
- [23] Mattias Frihammar and Helaine Silverman. 2017. Heritage of death: landscapes of emotion, memory and practice. Routledge. 244 pages.
- [24] Eman Gadalla. 2016. Second Life as a research environment: avatar-based focus groups (AFG). Qualitative Market Research: An International Journal 19, 1 (2016), 101–114. https://doi.org/10.1108/QMR-08-2015-0070
- [25] M. Dolores Gallego, Salvador Bueno, and Jan Noyes. 2016. Second Life adoption in education: A motivational model based on Uses and Gratifications theory. *Computers and Education* 100 (2016), 81–93. https://doi.org/10.1016/j.compedu. 2016.05.001
- [26] Martin Gibbs, James Meese, Michael Arnold, Bjorn Nansen, and Marcus Carter. 2015. #Funeral and Instagram: Death, Social Media, and Platform Vernacular. Information Communication and Society 18, 3 (2015), 255–268.
- [27] Peter Joseph Gloviczki. 2015. Journalism and Memorialization in the Age of Social Media. Springer. 185 pages.
- [28] Stine Gotved. 2015. Privacy with public access: digital memorials on quick response codes. Information, Communication & Society 18, 3 (2015), 269–280.
- [29] Hannah Gould, Tamara Kohn, and Martin Gibbs. 2018. Uploading the ancestors: Experiments with digital Buddhist altars in contemporary Japan. *Death Studies* 43, 7 (2018), 456–465.
- [30] Connor Graham, Michael Arnold, Tamara Kohn, and Martin R. Gibbs. 2015. Gravesites and websites: a comparison of memorialisation. *Visual Studies* 30, 1 (2015), 37–53.
- [31] Rebecca Gulotta, William Odom, Haakon Faste, and Jodi Forlizzi. 2014. Legacy in the Age of the Internet: Reflections on How Interactive Systems Shape How We Are Remembered. (2014), 975–984. https://doi.org/10.1145/2598510.2598579
- [32] Rebecca Gulotta, William Odom, Jodi Forlizzi, and Haakon Faste. 2013. Digital Artifacts As Legacy: Exploring the Lifespan and Value of Digital Data. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (2013), 1813– 1822. https://doi.org/10.1145/2470654.2466240
- [33] Jonna Häkkilä, Ashley Colley, and Matilda Kalving. 2019. Designing an Interactive Gravestone Display. PerDis '19 Proceedings of the 8th ACM International Symposium on Pervasive Displays (2019), 4:1–4:7.
- [34] Jonna Häkkilä, Meri-Tuulia Forsman, and Ashley Colley. 2018. Navigating the Graveyard: Designing Technology for Deathscapes. (2018), 199–204.
- [35] Jonna Häkkilä, Petri Hannula, Elina Luiro, Emilia Launne, Sanni Mustonen, Toni Westerlund, and Ashley Colley. 2019. Visiting a Virtual Graveyard: Designing Virtual Reality Cultural Heritage Experiences. MUM '19 Proceedings of the 18th International Conference on Mobile and Ubiquitous Multimedia (2019), 56:1–56:4.
- [36] Michelle Hlubinka, Jennifer Beaudin, Emmanuel Munguia Tapia, and John S. An. 2002. AltarNation: interface design for meditative communities. CHI '02 extended abstracts on Human factors in computing systems (2002), 612–613.
- [37] Rosalie Hooi and Hichang Cho. 2013. The Virtual "Me" is the Actual Me: Self-Disclosure in Virtual Environment. In Proceedings of the 2013 46th Hawaii International Conference on System Sciences (HICSS '13). IEEE Computer Society, USA,

883-892. https://doi.org/10.1109/HICSS.2013.546

- [38] Jonna Häkkilä, Ashley Colley, Matilda Kalving, and Meri-Tuulia Forsman. 2020. Exploring pervasive displays for cemeteries and memorial sites. *Personal and Ubiquitous Computing* (2020). https://doi.org/10.1007/s00779-019-01359-1
- [39] Castle Jason and L. Phillips William. 2003. Grief Rituals: Aspects That Facilitate Adjustment to Bereavement. Journal of Loss and Trauma 8, 1 (2003), 41–71.
- [40] Hirokazu Kato, Mark Billinghurst, and Mark Billinghurst. 1999. Marker Tracking and HMD Calibration for a Video-Based Augmented Reality Conferencing System. In Proceedings of the 2Nd IEEE and ACM International Workshop on Augmented Reality (IWAR '99). IEEE Computer Society, Washington, DC, USA, 85–. http: //dl.acm.org/citation.cfm?id=857202.858134
- [41] Tamara Kohn, Martin Gibbs, Bjorn Nansen, and Luke van Ryn. 2019. Residues of Death. Routledge. 200 pages.
- [42] Jeremy Layton. 2019. 9/11: How NYC, nation will observe 18th anniversary. New York Post (2019). https://nypost.com/2019/09/10/9-11-how-nyc-nation-willobserve-18th-anniversary/ Accessed: 2019-12-20.
- [43] Yuhu Liu, Takeru Hashimoto, Shigeo Yoshida, Takuji Narumi, Tomohiro Tanikawa, and Michitaka Hirose. 2019. ShapeSense: A 2D Shape Rendering VR Device with Moving Surfaces That Controls Mass Properties and Air Resistance. In ACM SIGGRAPH 2019 Emerging Technologies (Los Angeles, California) (SIGGRAPH '19). ACM, New York, NY, USA, Article 23, 2 pages. https: //doi.org/10.1145/3305367.3327991
- [44] Mainichi Japan. 2019. Kyoto residents' group asks KyoAni not to build memorial at arson attack site. *The Mainichi* (2019). https://mainichi.jp/english/articles/ 20191226/p2a/00m/0na/002000c Accessed: 2020-1-5.
- [45] Michael Massimi and Ronald M. Baecker. 2011. Dealing with Death in Design: Developing Systems for the Bereaved. CHI '11 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (2011), 1001–1010.
- [46] Michael Massimi and Andrea Charise. 2009. Dying, death, and mortality: towards thanatosensitivity in HCL. CHI EA '09: Proceedings of the 27th international conference extended abstracts on Human factors in computing systems (2009), 2459– 2468.
- [47] Poppy Lauretta McLeod, Yi-Ching Liu, and Jill Elizabeth Axline. 2014. When Your Second Life Comes Knocking. *Comput. Hum. Behav.* 39, C (2014), 59–70. https://doi.org/10.1016/j.chb.2014.06.025
- [48] Joshua McVeigh-Schultz, Anya Kolesnichenko, and Katherine Isbister. 2019. Shaping Pro-Social Interaction in VR: An Emerging Design Framework. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (Glasgow, Scotland Uk) (CHI '19). Association for Computing Machinery, New York, NY, USA, Article 564, 12 pages. https://doi.org/10.1145/3290605.3300794
- [49] Wendy Moncur, Jan Bikker, Elaine Kasket, and John Troyer. 2012. From death to final disposition: roles of technology in the post-mortem interval. CHI '12 Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems (2012), 531–540.
- [50] Wendy Moncur, Miriam Julius, Elise van den Hoven, and David Kirk. 2015. Story Shell: The Participatory Design of a Bespoke Digital Memorial. (2015), 470–477.
- [51] Wendy Moncur and David Kirk. 2014. An Emergent Framework for Digital Memorials. Proceedings of the 2014 Conference on Designing Interactive Systems DIS '14 (2014), 965–965.
- [52] Aron Moss. [n.d.]. Why No Flowers on Jewish Graves? https: //www.chabad.org/library/article_cdo/aid/1911395/jewish/Why-No-Flowerson-Jewish-Graves.htm Accessed: 2021-1-5.
- [53] Takuji Narumi, Yuki Ban, Takashi Kajinami, Tomohiro Tanikawa, and Michitaka Hirose. 2012. Augmented Perception of Satiety: Controlling Food Consumption by Changing Apparent Size of Food with Augmented Reality. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Austin, Texas, USA) (CHI '12). ACM, New York, NY, USA, 109–118. https://doi.org/10.1145/ 2207676.22076693
- [54] Takuji Narumi, Shinya Nishizaka, Takashi Kajinami, Tomohiro Tanikawa, and Michitaka Hirose. 2011. Augmented Reality Flavors: Gustatory Display Based on Edible Marker and Cross-modal Interaction. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Vancouver, BC, Canada) (CHI '11). ACM, New York, NY, USA, 93–102. https://doi.org/10.1145/1978942.1978957
- [55] William Odom, Richard Banks, David Kirk, Richard Harper, Siân Lindley, and Abigail Sellen. 2012. Technology heirlooms?: considerations for passing down and inheriting digital materials. Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems CHI '12 (2012), 337–337.
- [56] William Odom, Daisuke Uriu, David Kirk, Richard Banks, and Ron Wakkary. 2018. Experiences in Designing Technologies for Honoring Deceased Loved Ones. Design Issues 34, 1 (2018), 54–66.
- [57] Okiseki Co., Ltd. 2018. Ohaka-Mairu. http://www.okiseki.com/app/.
- [58] ONLINE TORO NAGASHI (LANTERN FLOATING FESTIVAL). 2020. ONLINE TORO NAGASHI (LANTERN FLOATING FESTIVAL) × HIROSHIMA RIVER OF LOVE 2020. http://tourounagashi.org/en.html Accessed: 2020-9-17.
- [59] OQTA. [n.d.]. OQTA Dove Clock. https://www.oqta.com/usa Accessed: 2020-9-17.
- [60] Tekla S. Perry. 2016. Virtual reality goes social. IEEE Spectrum 53, 1 (2016), 56-57.

- [61] Stacey Pitsillides. 2019. Digital legacy: Designing with things. Death Studies 43,
- (2019).
 Michael Ray. 2013. Sandy Hook Elementary School shooting. *Britannica* (2013). https://www.britannica.com/event/Newtown-shootings-of-2012 Accessed: 2019-12-30.
- [63] Bronna D. Romanoff. 1998. Rituals and the Grieving Process. Death Studies 22, 8 (1998), 697–711.
- [64] Alice Running, Lauren Woodward Tolle, and Deb Girard. 2008. Ritual: The final expression of care. International Journal of Nursing Practice 14, 4 (2008), 303–307.
- [65] Corina Sas, Steve Whittaker, Steven Dow, Jodi Forlizzi, and John Zimmerman. 2014. Generating Implications for Design through Design Research. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Toronto, Ontario, Canada) (CHI '14). Association for Computing Machinery, New York, NY, USA, 1971–1980. https://doi.org/10.1145/2556288.2557357
- [66] Corina Sas, Steve Whittaker, and John Zimmerman. 2016. Design for Rituals of Letting Go: An Embodiment Perspective on Disposal Practices Informed by Grief Therapy. ACM Trans. Comput.-Hum. Interact. 23, 4 (2016), 21:1–21:37.
- [67] Jotaro Shigeyama, Takeru Hashimoto, Shigeo Yoshida, Takuji Narumi, Tomohiro Tanikawa, and Michitaka Hirose. 2019. Transcalibur: A Weight Shifting Virtual Reality Controller for 2D Shape Rendering Based on Computational Perception Model. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (Glasgow, Scotland Uk) (CHI '19). ACM, New York, NY, USA, Article 11, 11 pages. https://doi.org/10.1145/3290605.3300241
- [68] Robert John Smith. 1974. Ancestor Worship in Contemporary Japan. Stanford University Press. 288 pages.
- [69] Dag Svanaes and William Verplank. 2000. In Search of Metaphors for Tangible User Intefaces. In Proceedings of DARE 2000 on Designing Augmented Reality Environments (Elsinore, Denmark) (DARE '00). Association for Computing Machinery, New York, NY, USA, 121–129. https://doi.org/10.1145/354666.354679
- [70] The Guardian. 2019. 'Too painful': Kyoto anime fans join prime ministers in mourning fire victims. https://www.theguardian.com/world/2019/jul/19/too-painfulkyoto-anime-fans-join-prime-ministers-in-mourning-fire-victims Accessed: 2019-12-30.
- [71] The Yomiuri Shimbun. 2019. Victims of Kawasaki fatal stabbing mourned. https: //the-japan-news.com/news/article/0005773889 Accessed: 2019-12-27.
- [72] Daisuke Uriu, Ju-Chun Ko, Bing-Yu Chen, Atsushi Hiyama, and Masahiko Inami. 2019. Digital Memorialization in Death-Ridden Societies: How HCI Could Contribute to Death Rituals in Taiwan and Japan. Human Aspects of IT for the Aged Population. Design for the Elderly and Technology Acceptance (2019), 532–550.
- [73] Daisuke Uriu and William Odom. 2016. Designing for Domestic Memorialization and Remembrance: A Field Study of Fenestra in Japan. Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems CHI '16 (2016), 5945–5957.
- [74] Daisuke Uriu, William Odom, and Hannah Gould. 2018. Understanding Automatic Conveyor-belt Columbaria: Emerging Sites of Interactive Memorialization in Japan. Proceedings of the 2018 Designing Interactive Systems Conference (2018), 747–752.
- [75] Daisuke Uriu, William Odom, Mei-Kei Lai, Sai Taoka, and Masahiko Inami. 2018. SenseCenser: An Interactive Device for Sensing Incense Smoke & Supporting Memorialization Rituals in Japan. Proceedings of the 2018 ACM Conference Companion Publication on Designing Interactive Systems (2018), 315–318.
- [76] Daisuke Uriu, Takahiro Ogasawara, Naohito Shimizu, and Naohito Okude. 2006. MASTABA: The Household Shrine in the Future Archived Digital Pictures. ACM SIGGRAPH 2006 Sketches, Article 151 New York, NY, USA (2006).
- [77] Daisuke Uriu and Naohito Okude. 2010. ThanatoFenestra: photographic family altar supporting a ritual to pray for the deceased. Proc. of DIS '10 (2010), 422–425.
- [78] Jayne Wallace, Kyle Montague, Trevor Duncan, Luís P. Carvalho, Nantia Koulidou, Jamie Mahoney, Kellie Morrissey, Claire Craig, Linnea Iris Groot, Shaun Lawson, Patrick Olivier, Julie Trueman, and Helen Fisher. 2020. ReFind: Design, Lived Experience and Ongoingness in Bereavement. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (Honolulu, HI, USA) (CHI '20). Association for Computing Machinery, New York, NY, USA, 1–12. https: //doi.org/10.1145/3313831.3376531
- [79] Jayne Wallace, James Thomas, Derek Anderson, and Patrick Olivier. 2018. Mortality as Framed by Ongoingness in Digital Design. *Design Issues* 34, 1 (2018), 95–107.
- [80] Tony Walter. 2015. Communication media and the dead: from the Stone Age to Facebook. *Mortality* 20, 3 (2015), 215–232.
- [81] John Zimmerman, Jodi Forlizzi, and Shelley Evenson. 2007. Research through design as a method for interaction design research in HCI. CHI '07: Proceedings of the SIGCHI conference on Human factors in computing systems (2007), 493–502.
- [82] Fabio Zünd, Mattia Ryffel, Stéphane Magnenat, Alessia Marra, Maurizio Nitti, Mubbasir Kapadia, Gioacchino Noris, Kenny Mitchell, Markus Gross, and Robert W. Sumner. 2015. Augmented Creativity: Bridging the Real and Virtual Worlds to Enhance Creative Play. In SIGGRAPH Asia 2015 Mobile Graphics and Interactive Applications (Kobe, Japan) (SA '15). ACM, New York, NY, USA, Article 21, 7 pages. https://doi.org/10.1145/2818427.2818460