

Generating the Presence of Remote Mourners: a Case Study of Funeral Webcasting in Japan

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Figure 1: Left: Checking our 360-degree webcasting system in the funeral hall, Center: The chief mourner Takako gave mourners greetings, webcasted on Zoom, Right: She is remotely showing her departed husband's portrait to his elder sisters

ABSTRACT

Funerals are irreplaceable events, especially for bereaved family members and relatives. However, the COVID-19 pandemic has prevented many people worldwide from attending their loved ones' funerals. The authors had the opportunity to assist one family faced with this predicament by webcasting and recording funeral rites held near Tokyo in June, 2020. Using our original 360-degree Telepresence system and smartphones running Zoom, we enabled the deceased's elder siblings to remotely attend the funeral and did our utmost to make them feel present in the funeral hall. Despite the webcasting via Zoom contributing more to their remote attendances than our system, we discovered thoughtful findings which could be

useful for designing remote funeral attendances. From the findings, we also discuss how HCI designers can contribute to this highly sensitive issue, weaving together knowledge from various domains including techno-spiritual practices, thanato-sensitive designs; and other religious and cultural aspects related to death rituals.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**.

KEYWORDS

Funeral; Death Rituals; Techno-spiritual practices; Thanato-sensitivity; Mourning and Memorialization; Telepresence and Telexistence; 360-degree camera

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1 INTRODUCTION

Funerals always happen suddenly and people who want to attend are sometimes, unfortunately, unable to join. The COVID-19 pandemic has made many people unable to attend funerals worldwide, but webcasting technology has been applied to support them (e.g., [34, 47]). However, there is still a gap in the quality of experience between physical and remote attendances. For example, with one-way webcasting, it is impossible for remote attendees to hold physical rituals such as offering flowers or burning incense tips, and touch the loved one's body or hold his/her casket. This research's main concern is how HCI technology can fill this quality gap and contributes to remote mourners, allowing them to not only passively view a live stream of the funeral rites but also actively hold rituals and say farewells to the deceased.

In the middle of June, 2020, we had a sudden opportunity to webcast a funeral in order to connect a funeral hall with bereaved relatives and others who were unable to attend in person. A deceased man *Takashi*¹ passed away at age 74. He was the second-youngest of eight siblings. Only his two sisters were able to physically attend the funeral. The others decided not to join due to the risk of contracting COVID-19 and their decreasing physical strength. *Takashi*'s wife *Takako* attended in person while her friends remotely attended the funeral via our webcasting. It should be noted here that *Takako* and her friends are members of our lab's research project providing technical workshops to seniors and familiar with using technology associated to viewing webcasts. Our scenario, thus, gave us the opportunity to provide remote funeral attendance services to persons both familiar and unfamiliar with using the technology.

Our initial motivation was to investigate how our previous experience in 360-degree video recording and interactive broadcasting could be applied to support remote funeral attendance. Our original broadcasting system consists of several fixed "Node" modules (including several 360 cameras, microphones, and speakers) and a "Viewer" through which remote users can join Nodes via Internet. The system allows for Viewers to see and hear things at the Node's location and communicate sonically with persons around the Node. The original version of this system was presented at IEEE VR 2019 [27]. However, when we were asked to assist in remote attendance by providing a webcasting service, we were in the middle of updating our system to be more reliable. Specifically, we were in the midst of improving it to be used outside the research lab and by untrained persons in the wild settings [9]. As a result, unfortunately, we were forced to use some equipment which was not fully tested at the time. Moreover, we did not have the time to configure it for use at a funeral or funeral hall and were not able to predict potential problems which could (and did) occur during operation. Therefore, as a backup measure, we also prepared smartphones with the remote-conference application *Zoom* in case the system failed. In fact, during the webcasting, the mobility of smartphone and the interactive communication functionality of *Zoom* contributed greatly to the remote attendees' experience. This paper illustrates how our research team—with our webcasting and recording technology—participated in a contemporary Japanese funeral and supported remote attendance.

As noted above, before the funeral, we originally intended to use this sudden and unique opportunity to validate our original system by showing how it can contribute to remote funeral attendance. However, during the funeral, we noticed that using *Zoom* on smartphones performed more consistently than the current version of our system and discovered that this aspect was more valuable to the remote viewers than the 360-view our system could provide. Our focus then shifted to generating a sense of presence for the remote mourners. Therefore, this paper mainly reports on the experience of how we, the authors, tried to contribute to the bereaved family members, the feedback we received from them and the other remote attendees. While this includes an overview of the technical difficulties we faced throughout this case study the paper more strongly emphasizes reporting the unique experiences of both the mourners and we who supported the mourners by providing webcasting services.

Live webcasting of funerals itself is not new. Rather, it is rapidly gaining popularity after the advent of the COVID-19 pandemic. However, it remains a topic of great interest to the research community, because there has been no in-depth study of the real user experience of the remote mourners, and the existing systems have much room for improvement [47]. We believe that the major challenge we faced was providing a sense of interactivity between physical attendees and remote ones. To realize this interactivity, we tried to transfer the "presence" of the deceased's elder siblings to the funeral hall, allowing them to feel as if they were really attending and holding farewell rituals. From our observations during this case study, we will argue, in the discussion, what kinds of HCI technology (e.g., Telepresence, Virtual Reality, etc.) should be developed for and adopted to funeral rites that interweave techno-spiritual practices [4, 74], thanato-sensitivity [39, 40], and complex cultural aspects (in this case, an urban area in Japan).

2 BACKGROUND AND RELATED WORKS

2.1 Contemporary Funerals in Japan

The contemporary Japanese Buddhist funeral ceremony [51, 63] takes two days: the 1st day, which consists of the *Tsuya* (a kind of wake, "the last night" that the bereaved may stay with the deceased), and the 2nd day, which consists of the *sōgi* [funeral] and *kokubetsushiki* [Farewell Ceremony]. The cremation is conducted after the *kokubetsushiki* on the same day. On both days, the ceremonies take around one hour each for a total of two hours. A Buddhist priest (the leader) holding rituals accounts for 90% of the total time. Physical attendees also hold the burning incense (*shōko*) ritual [66] several times while the priest is chanting a Buddhist sutra. However, while the Buddhist priest mainly leads the religious rites and takes the largest portion of time during the funeral ceremonies, for the bereaved family and other mourners, the final 5-10 minutes—when they fill the casket with flowers, say their farewells to the deceased, and give him any last messages—is the highlight and the most important moment of the funeral. Because 99.9% of corpses in Japan are cremated nowadays [63], the last farewell minutes before the casket is moved to the crematorium are the most important for the bereaved. At crematorium, the corpse in casket will be immediately cremated at the scheduled time. At this point, though limited, the bereaved may see the deceased's face for just a moment through a

¹All names described in this paper are aliases instead of real names.

small window. Since any photography or video shooting is strictly prohibited at the crematorium, any live broadcasting must end at the funeral hall.

The funeral we participated in was conducted in Chiba prefecture (close to Tokyo metropolis) and also followed these procedures. Almost all remote attendees joined for both of the two days. While we took care to broadcast all scenes of the ceremony, we especially focused on supporting the remote attendees by not only allowing them to view the rites held by the priest but also to “participate” in the final farewell and the deceased’s “departure” ceremony.

2.2 Toward Techno-death Rituals

As noted in the Introduction, we are not the first to propose webcasting for supporting remote funeral attendance. Neither are we the first to suggest linking HCI technologies to spiritual practices. There has been significant research done in the HCI research community focusing on spiritual practices in the last decades. Bell [4] and Wyche et al. [74] initially proposed the idea of “techno-spiritual practices” in 2006. Each of them described existing phenomena and future visions of how HCI technologies can be adopted in spiritual practices. Other researchers have also sought to apply HCI technologies for supporting religious practices (e.g., [13, 73]). Commercial products like smartphone applications for this purpose are becoming especially popular as of late [8]. Techno-spiritual practices, while not directly connected with death rituals yet, have been widely accepted by the religious communities.

With regard to death rituals, Massimi et al. [40] proposed the concept of “thanatosensitive design,” design that engages with the many issues bound to mortality, dying, and death through the creation of interactive systems. Research in this area has mostly focused on exploring post-funeral thanatosensitive design. For example, past research has studied the transfer of digital possessions belonging to the departed [6, 17, 18, 45] and support for the grieving [7, 39]. In comparison, the funeral, an example of a thanatosensitive event, has not been comprehensively surveyed yet. One of the few articles discussing this area focuses on the period immediately after death: the post-mortem interval (PMI) [41]. In this work Moncur et al. investigated how death workers [72] (funeral directors, celebrants, bereavement counselors, lawyers, police, coroners, embalmers, and Disaster Victim Identification workers) utilize technology.

One direction of thanatosensitive design that has received significant attention in recent years is that of domestic memorialization. Uriu, the first author of this paper, and others have proposed the concept of a digital family shrine for people to remember deceased relatives called “MASTABA” [67], interactive altars using candle fire called “ThanatoFenestra” [68] and “Fenestra” with deployment studies [64], and an incense smoke interface for memorialization practices called “SenseCenser” [66]. Wallace et al. suggested a digital locket that enables a digital legacy to be archived along with narratives about the deceased [71]. They have also recently proposed a small photo viewer called “ReFind” [70] that brings up photos of the deceased based on newly taken photos. Moncur and Kirk offered a framework for designing digital memorials [43], and designed “Story Shell” [42], an interactive sound player that is specialized for archiving and playing back stories about the deceased. Odom et al. [46] modeled the design of future technologies aimed

at supporting a relationship between the living and the dead. Pitsilides [50] proposed a method for creating new forms of agency for the dead by arranging the digital legacies the deceased leave.

Another well-studied direction of thanatosensitive design is the use of technology at gravesites or in cemeteries. Gotved [15] surveyed QR codes on gravestones in Denmark and revealed how people adopted a digital memorial culture which connected physical sites with virtual memories. Hakkila et al. designed a location-aware navigation application at a graveyard [21], a dynamic gravestone with different content triggered by inserting RFID cards [19], a virtual graveyard [22]; and generally argued how pervasive displays could be installed in cemeteries and at memorial sites [20]. 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 [65]. Gould et al. [16] described contemporary secularizations of domestic memorialization rituals in Japan, bringing up digitalized Buddhist home altars (*butsudan*) as examples.

When working with “techno-death rituals,” especially when considering how HCI technology could support funerals and other death rituals, researchers need to understand previous works from techno-spiritual practices, thanatosensitive designs, and other technical practices on memorialization. In the area of death rituals, there is a complex of religious thoughts and traditions, spirituality, emotional feeling, sensitivity and grief, requirements from the society (including the pandemic situation), etc that must be considered when conducting research and design. In this research, thus, we had to take into consideration all of the above as we leveraged webcasting, telecommunication, and Telepresence/Telexistence technologies to assist in remote funeral attendance.

2.3 Funeral Live Streaming

Due to the COVID-19 pandemic in 2020, numerous news articles reported the webcasting of funerals (e.g., [34, 47]) and some religious communities were forced to change the way in which they conducted death rituals (e.g., [3, 28]). For example, although 99.9% people living in Japan are cremated nowadays, it was strictly forbidden for the bereaved family to hold farewell ceremonies with the corpse of a deceased who passed away due to COVID-19 [75]. Some funeral companies in Japan began to provide live-streaming services and are trying to digitalize their funeral services in order to accommodate families who are unable to conduct funerals because of the new restrictions [55]. However, the utilization of digital technology is still not popular, and many funerals are either decreased in size, postponed, or even canceled [37].

The concept of remote funeral attendance itself is not new. There were several companies providing live-streaming or webcasting services for funerals even before the pandemic (e.g., [38]). However, these services had not been widely accepted yet. One of the reasons for this is that some funeral directors—who thought that broadcasting the grieving bereaved family members was unethical—denying adoption of the services [69]. In Japan in particular, there was no major service provider of funeral webcasting before the pandemic. Recently, however, a relatively large funeral company *Hibiya Kadan* published a press release on May 2020 [44] in which it announced the start of their free funeral webcasting service via Youtube Live.

Although it is impossible to predict the future, it seems that webcasting or remote attendance has become more prevalent in funerals since the advent of COVID-19.

2.4 Telepresence and Telexistence

Researchers developing remote communication systems, especially focusing on Telepresence and Telexistence systems, are working towards sending the presence of a person to remotely connected sites as if the person were physically there. One approach for achieving this is through the use of cutting-edge robotics technologies. For example, there are numerous works which allow the remote person to send gestures [1, 62], facial expressions [1, 61, 76], mobility controls [25, 48, 76], and physical movements [58, 59], in addition to audio/video communications. However, these approaches typically require huge and complicated hardware that has to be physically taken care of by local participants [25] and might be obstacles for people remotely connected [52].

Other approaches focus on designing mobile/wearable systems and/or the use of 360-degree cameras. For example, Kratz et al. [33] proposed a shoulder mounted tele-presence device that enables remote users to control their direction of view and to explore an environment. Kashiwabara et al. [30] developed a remote avatar mounted on the shoulder, of which a user can remotely control the direction of its head. Kasahara et al. [29] gave remote users stabilized first-person views through a head-mounted 360-degree camera. Shibahara et al. [54] allowed multiple users to jump around among multiple live-streamed 360-degree videos. The last of these was partially adapted for use in our webcasting of Takashi's funeral.

When webcasting the funeral, we focused on transferring and exchanging presences between the remotely connected people while keeping the mobility and the space-saving design of our original system. Therefore, we opted to install multiple 360-degree cameras at the funeral hall and provided a viewing browser with which remote users may change the camera position. We also prepared multiple portable devices for running *Zoom* that provided high mobility and wearability. The findings and insights from this research illustrates what our research team was able to achieve with a highly limited Telepresence/remotely communication solution at short notice and how we could be more prepared in the future.

2.5 The Technology Supported Death Rituals

This research mainly provides a case study of techno-death rituals weaving religious practices, and death and memorialization rituals with thanato-sensitive designs; utilizing Telepresence and webcasting techniques. Using sociologist Erving Goffman's theory described in *The Presentation of Self in Everyday Life* [14], a funeral can be modeled as a "performance" in which all attendees at the funeral play different roles. These roles include the priest, the deceased family members, other attendees, and even supporting staff (including the authors in this paper). With the support of Telepresence technologies, remote attendees were also able to get involved in this funeral, and performed their respective roles. Not only were they able to experience the funeral, but their presences and performances were appreciated by people at the funeral hall. Our findings from this research leads to a discussion of how remote and onsite mourners may collaboratively conduct technology-supported death

rituals, and the kind of Telepresence designs and technologies that should be investigated for future practices. The discussion also provides several implications for designing remote funeral attendances and other death rituals, comprehensively taking into consideration techno-spiritual practices, thanato-sensitive designs, interaction designs for mourning and memorialization, and other religious and cultural aspects.

3 METHODOLOGY

3.1 Overview

The privately owned funeral hall from which we webcasted is located in Kashiwa-city, Chiba prefecture. On the other hand, Takashi (the deceased)'s elder brothers and sisters, who remotely participated in the funeral, live in Oume-city, Tokyo. Oume-city is more than two hours away from the funeral hall by train or car. However, the travel time was not the reason why Takashi's siblings was not able to attend. Takashi died on Thursday and the funeral was held on the next Monday evening and Tuesday morning. The reason for their inability to attend was their physical conditions. All of them are over 75 years old and it would have been physically stressful for them to make the trip and attend the two-day funeral, even with the assistance of younger people. This problem was compounded by the high risk of contracting COVID-19 at the time. Takashi's wife, Takako, (the chief mourner, *moshu*) encouraged them not to come for the sake of their health. As a result, they decided not to attend the funeral, along with many younger relatives living close to them.

However, the siblings were still eager to attend the funeral. Responding to their wish, Takako initially thought to record the funeral rites with a 360-degree camera herself and have them view the video after the funeral. At this point, she consulted us about how to setup cameras at the funeral hall as she knew we had experience using the technology. However, she had a significant amount of other work to do as the chief mourner at the funeral, despite grieving her husband. Hoping to assist her in her time of need, we offered to participate in the funeral to record and webcast the ceremonies to her husband's siblings. Takako and other family members accepted our offer, and the siblings were also glad to hear that they would be able to "attend" their younger brother's funeral.

Funerals are highly sensitive and private events. This is especially true for contemporary Japanese funerals, which sometimes do not invite many visitors other than close relatives [26, 56]. We were initially worried about being unwelcome outsiders participating in the event. In particular, we were worried about what the funeral hall staff and the Buddhist priest, the leader holding solemn rites, would think and whether they would allow us to work. Fortunately, the funeral hall staff and priest accepted us and our activities. Furthermore, and more notably, the bereaved family members, including Takashi and Takako's sons, highly welcomed and supported us and expressed their high expectations regarding our ability to connect Takashi's siblings to the funeral hall.

3.2 Internet Access

The greatest technical bottleneck we experienced in Webcasting the funeral was Internet accessibility. Neither the the funeral hall

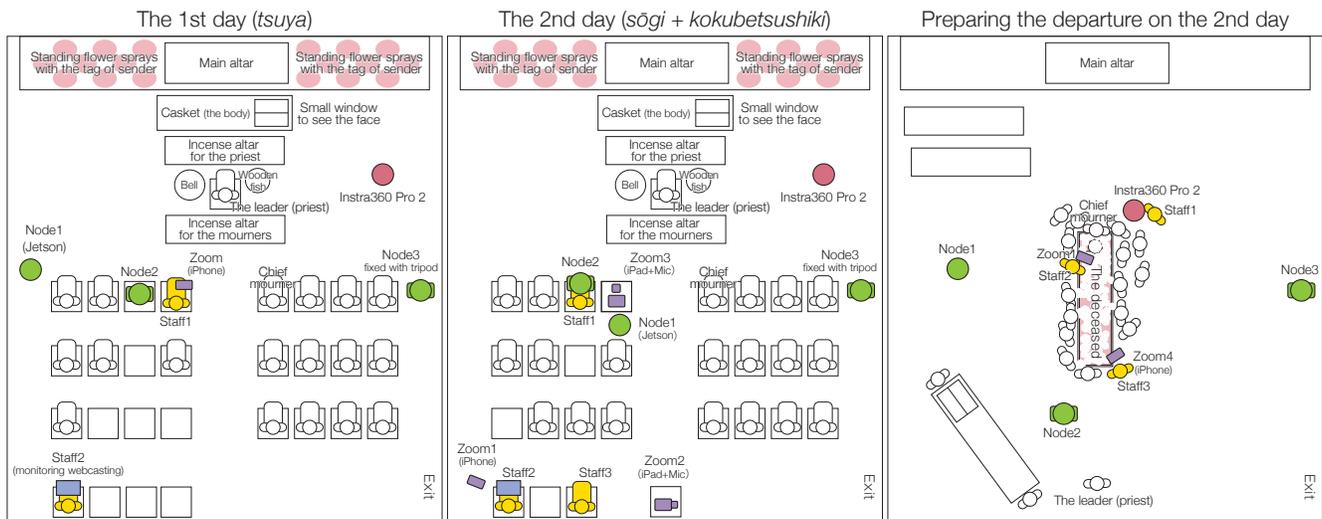


Figure 2: Transition of layouts and settings of the funeral hall

or the home where the siblings gathered had a high-speed broadband connection. To enable Internet access at the funeral hall we brought mobile-WiFi devices and smartphones with tethering functionality. At Takashi’s siblings’ home, Internet accessibility was enabled through a mobile-WiFi device. Since none of the siblings were familiar with digital devices, one of the authors visited their home to operate the equipment and act as a communication hub between people in the hall and the siblings.

3.3 The Funeral Participants

Here, we introduce persons appearing in this paper, defining their names as well as giving a short description of each.

3.3.1 The bereaved family. The deceased *Takashi* passed away at 74 years of age after fighting an intractable disease for several years. His disease was such that he was lucid and communicated with family members well even in his last days. Therefore, his wife *Takako* and his children felt that he passed away suddenly. This is even though all of them intellectually understood that *Takashi*’s condition had been continually getting worse.

As mentioned, *Takako* was a chief mourner (*moshu*) and represented the bereaved family. As the chief mourner, she had to handle many things for the funeral such as preparing the funeral altar, casket, urn, and deceased’s portrait picture *iei*, and communicating with the funeral company staff. *Takashi* and *Takako*’s sons (elder son: *Takahiro* and second son: *Hiromasa*) supported her for many of these tasks. Since *Takako* was terribly busy at the funeral, we sometimes communicated with *Takahiro* or *Hiromasa* to configure our settings.

3.3.2 Our staff (research group members). Taking inspiration from the participatory design and research methodology [11, 23], our research team members (Staff 1-5 denoted as [S1-5] in this paper) also attended the funeral. Three of the members (S1-3) attended

the funeral at the funeral hall while S4 attended remotely and supported the siblings at their home. S5 remotely supported the other staff from his home. At the funeral, S1 was mainly in charge of managing 360-degree video and audio recording at the hall, and also actively attended the funeral by sitting at the front of the hall. S2 mainly contributed to the webcasting as a main contact person with the deceased’s family members. He also negotiated conducting the funeral recording and webcasting with the staff at the funeral company, and contacted a younger person living with the deceased’s siblings to make the necessary on-site arrangements. S3 physically setup the 360-camera system in the hall and communicated with S5 who was in charge of network programming. S3 only attended the 2nd day. Since the siblings required technical support to remotely attend the funeral, S4 visited one of their houses and remotely attended the funeral with them.

Before the funeral, S1-2 communicated with *Takako* via Facebook messenger, had an online meeting on Zoom. After this, S2 led the other staff members in preparing for each settings. During the funeral rites, all staff communicated via a *LINE* (an instant messenger) group to exchange situations. In the morning of the 2nd day, *Takahiro* and *Hiromasa* also joined our *LINE* group and we collaborated to make the webcasting a success.

3.3.3 Takashi’s siblings. *Takashi* was the second-youngest of eight siblings. Two of his siblings attended physically: one younger sister (age 71) and another elder sister (age 77). The eldest sister had already passed away at the time of the funeral. The eldest brother (age 85) was staying at a care house and was not able to join. *Takashi*’s two elder sisters: *Masako* (age 88) and *Masami* (age 80) were able to join remotely for both days of the funeral. The second brother *Masataka* (age 82) was only able to join for the 2nd day. Several other relatives also attended remotely along with the attending siblings. When the siblings had any request for the people at the hall, they asked S4 and he passed on the request to other staff at the funeral hall via *LINE*. Other younger relatives also sent messages

to Takahiro and Hiromasa at the hall to convey requests from the siblings. These were transferred to S2 on the morning of the 2nd day.

3.3.4 Takako’s friends (senior group members). Through our webcasting, five of Takako’s friends were also able to remotely attend the funeral. These five friends are part of the same senior group organized by our lab and led by S1. Since Takako adopted the style of family funeral that only invites family and close relative members to the funeral, these friends were originally not invited to attend physically. However, when attending remotely via webcasting became an option, she called for them to participate online.

We describe these members as Friends 1-5 [F1-5] in this paper. F1, a 63-year-old male, had a handicap caused by a subarachnoid hemorrhage, and joined the funeral from a hospital room with his wife F2 (age 60). He usually uses a wheelchair and is able to go outside, but had to stay at the hospital due to a bad physical condition when the funeral was due to be held. F3 (female, age 67), F4 (female, age 71), and F5 (female, age 83) joined from their respective houses. F1-5 were all good at using digital tools such as PCs, tablet, etc. S1 occasionally communicated with them via Facebook messenger, sending them the URL for joining the webcast. All of them successfully attended without need for assistance.

3.4 Webcasting Systems

Figure 2 illustrates a transition of layouts in the funeral hall during the ceremony. The figures include how we set up our system and allocated our staff in each layout. Noted in the figure are where we had our original equipment with software situated, and where we had *Zoom* working on smartphones and tables. On the first day, we initially booted only our system, but S1 launched *Zoom* on his iPhone in response to a request from the remotely attending siblings. We were notified that there were technical issues with our system that would not be able to be resolved immediately. In response to this, we set up multiple *Zoom* devices on the second day while attempting to keep our system running. Before moving the corpse to the crematorium, the casket was moved to the center of the hall and all mourners held a final farewell ceremony.

Our 360-degree webcasting system mainly consists of two components: Node(s) and Viewer(s). Each Node consists of a 360-degree camera *Insta 360 Air*, a microphone-speaker *eMeet M0* and a computer connected to the Internet. The Viewer is a web application that can be run in a web browser on any computer with a microphone to remotely connect with Nodes. A *WebRTC* based real-time communication platform connects the Node(s) and Viewer(s). Further details regarding the system architecture can be found in previous articles [27, 36] some of the authors were involved in.

Three Nodes were used to webcast the funeral: two *Microsoft Surface Go* version Nodes and one *NVIDIA Jetson Nano* version Node (Figure 3). The former version is designed as a box (Left, Figure 3) containing a *Surface Go* with a 4G SIM, an integrated camera-micro-speaker module, a fan, batteries, and other components. The latter version consists of an integrated module (Right, Figure 3) wired to a separated *Jetson Nano* connected to mobile WiFi via another 4G SIM. The *Jetson* version is expected to provide the better quality video by leveraging the hardware encoding on the device. Figure 4 shows an example comparing images received from the *Surface*



Figure 3: Node modules (Left: Surface Go version, Right: Jetson Nano version)



Figure 4: A comparison of quality of images from Nodes (Left: Surface Go version, Right: Jetson Nano version)

and the *Jetson*. However, the hardware encoding on the *Jetson* worked only on the first day. This was due to a critical break-down on a cloud server we were using experimentally to test the *Jetson* version at the time.

As we mentioned earlier, the critical technical bottleneck we faced was the lack of broad band Internet connectivity at the hall. In general, 360-degree video requires a much higher resolution than 16:9/4:3 video. The 4G connectivity we were able to receive was not sufficient for consistent and high-quality 360-degree video streaming. Moreover, we noticed that the audio pickup portion of the *eMeet M0* we adopted in our Nodes did not work well enough for capturing sounds at the funeral. While it was able to transfer the “atmosphere” of the funeral hall, it was unable to capture speeches made by the priest and Takako.

In the findings section, we will describe how our original system worked for several specific purposes on the first day. More generally, however, we will describe the limitations of our current prototype that led to many problems during the funeral. On the second day, we prepared another microphone (*IK Multimedia iRig Mic Field*)—personally owned by S2—and connected to the remote attendees via *Zoom* on an iPhone. Overall, the siblings used our 360-degree system on the first day with sound captured via *Zoom* on an iPhone by S1. On the second day, they mainly used *Zoom* webcasts instead.

3.5 360-degree Recording

To record the funeral rites (without streaming), we also set up an *Insta 360 Pro 2* 360-degree camera with a *ZOOM H3-VR* 360-degree sound capture device as described in Figure 2. This system was setup to capture a high-fidelity archive of the funeral. We provided this recording to Takako at her request by the 49th day

after the funeral. We prepared the recordings such that they could be privately browsed as a 360-degree YouTube video on either a computer or head mounted display. The 49th is significant here as it is the day one of the after-funeral memorial services are carried out and is also a day that family members gather.²

3.6 Setup at the Siblings' Home

As shown in Figure 5, the siblings gathered in a room with a TV monitor to view the funeral. We chose to output from our laptop to the TV via an HDMI cable as we thought that viewing remote locations through a TV monitor would be more familiar to the elderly siblings. We also prepared a webcam and positioned it to capture the siblings watching the funeral on the TV screen. S4 was dispatched to the siblings' location while the ceremony was conducted to operate our original 360-degree viewing browser and the Zoom interface as we expected that operating both systems would be challenging for the siblings.

Shown in the Figure 1 left and Figure 4 is the Viewer interface. In the Figures, we can see that there are thumbnails at the top of the interface that display the currently connected Node(s). The user can click one of these to change the user's point of view. By clicking and swiping the currently shown video feed, he/she can swing the field of view to see 360-degree around the camera.

3.7 Setup at Takako's Friends' Locations

F1-5 each prepared their own laptop and joined the ceremonies. On the first day, they were able to join via our system and Zoom. However, due to the fatal error on the cloud server, we switched to using an older version of our original system that did not allow multiple Viewers to join at the same time. Therefore, on the second day, we requested that F1-5 only join via Zoom, so that the siblings could use our system.

3.8 Data Collection and Ethical Approval

As mentioned, we video recorded all funeral rites. This was mainly done with the Insta 360 Pro 2, but also included occasional Zoom cloud recordings. Scenes of how the siblings remotely attended the funeral were also recorded by an iPhone. Each recording, taken on the 1st and 2nd days, is about two hours and half in length. F1-5 also recorded their own attendance to the funeral via 360-degree cameras they set up by themselves. After the funeral, we (S1-2) conducted an online interview with F1-5 and Takako on Zoom to receive feedback regarding their remote funeral attendance experience on July 19th, 2020 (about one month after the funeral). We did not prepared a formal structure for interview. F1-5 initially shared their impressions on the experience while we occasionally asked questions. We also conducted an interview with Takako, Takahiro, and Hiromasa on September 6th, 2020 (after the 49th days memorial service) to hear their thoughts on the the high resolution 360-degree recordings. They were also kind enough to share some stories about the times they showed the video recording to visitors

²In Japan, the bereaved family members live with the cremated ashes in their home until the 49th day's rite [57], regarding it as the presence of the deceased. After the duration, they generally store the urn in a gravestone or columbarium appropriately. On the 49th day, the bereaved family members and relatives gather, and the priest holds a set of rites. Therefore, we edited the high quality 360-degree recordings by this day to be seen by them.

who knew Takashi. Each interview conducted on Zoom took about one hour and were recorded.

The findings described in the next section come from the authors' notes and transcripts from these video recordings. These findings were reached by analyzing the data (recordings and transcripts) deductively with regard to their relevance to discussion of how HCI technology can contribute to funeral webcastings and transferring remote mourners' "presences" to the funeral hall as well as other important opinions leading thoughtful discussions. We did not adopt any formal coding approach for this analysis, as we did not aim to find any major and frequent opinions or keywords, nor formally evaluate our original system.

This research is ethically approved by the University of Tokyo. We also received permission to write this paper and use photographs from all the deceased's family members and Takako's friends. All the names of individuals described in this paper are aliases instead of real names.

3.8.1 Preventing the spread of COVID-19. We took the utmost care to minimize the health risks posed to those attending the funeral and at the siblings' home. We took care to wear masks at all times, follow social distancing guidelines published by the Japanese government, frequently sanitized our hands with alcohol, and minimized conversation with others who were on-site. We also checked our temperatures prior to leaving for the sites and paid the utmost attention to our health before, after, and during the funeral.

4 FINDINGS

4.1 The Funeral "Existed" at Places Remote Mourners Attended from

From the data we acquired, we found that funeral customs were not restricted to the funeral hall, but also pervaded the remote locations where people were attending the funeral from. For example, usually, the color of mourning clothes in Japan is black as shown in Figure 4. We noticed that Masako wore a mourning cloth on the 2nd day despite not being at the funeral hall. Takako's friends also mentioned their choice of clothes in the interviews. F5 said "*I wore mourning cloth or a formal shirt, in case I am shown at the hall.*" F1 also said "*I changed out of sleepwear into a white shirt.*" Other customs such as the use of prayer beads and flower offerings were also noted. For example, F2 said "*F1 held prayer beads and remotely attended the funeral from his bed at the hospital.*" F3 told us "*I joined the funeral, preparing flowers with the PC.*" These comments show that the remote mourners cared about the manners of attending a funeral and also arranged a "funeral place" at their own sites when they remotely joined the funeral.

Interestingly, it was not only the remote mourners but also others around them who also acted considerably towards the "existence of a funeral." F2 explained the situation in the hospital room with F1: "*I was kind of chaotic at first, because many people, helpers, nurses, doctors, other patients, etc., were coming and walking around us. But, once people noticed that we were attending a funeral, their attitudes were changed and they tried to act in a more serious manner.*" F5 also shared a similar story: "*There was a technical issue with my PC, so I asked my grand daughter next door to lend hers to me. She said 'There is a funeral next door! I have to keep quiet.'*" The social



Figure 5: The siblings remotely attended the funeral (Left: Checking who gave flower sprays, trying to see supplier tags, Center: Viewing the final preparation before moving to the crematorium, Right: Masataka is giving Takashi a farewell message via Zoom.)

meaning of funeral is very strong and greatly impacted the the remote mourners and their surroundings.

4.2 Contents Remote Mourners Require to See

As is common in a contemporary Japanese funeral, 90% of the time over the two days of funeral rites focused on the Buddhist priest holding rituals. However, for mourners attending the funeral, the highlight event is the last 10-15 minutes of the funeral where the mourners prepare for the departure of the deceased and the moving of the casket to the crematorium (Figure 2 Right). This is in contrast to broadcasts of a music live concert, where the musicians' performance, taking up over 90% of the time, is the main content. In funerals, while the mourners theoretically understand that the traditional ritual rites are required for the deceased's departure, their main reason for attending the funeral is to pay their last respects to the deceased. During the 90% of viewing ritual rites, the siblings relatively casually appreciated the webcasting, and gave the staff at the hall some requests via S4 to S1-3.

4.2.1 Mourners physically attended. At the beginning of the 1st day, the siblings requested that the camera angle be changed to see the faces of the attendees at the hall. In an attempt to show the siblings the faces of the attendees, S4 joined Node1, which had relatively good image quality. However, the quality was not enough to identify the faces of people attending. To better fulfill the siblings' request, S1 turned on Zoom on his iPhone and tried to show the attendees' faces. However, S4 interpreted, at the time, that the siblings just wanted to check who attended and did particularly care about the attendee's facial expressions. Thus, if we could have shared the list of physical attendees with the siblings, they may have been satisfied with that without needing any high-quality images via 360-degree webcasting.

4.2.2 Names of senders of standing flower sprays. In Japanese funerals, there is a custom where mourner(s)—including individuals, groups, organizations etc., related with the deceased—send flower sprays (*kyōka*) that will be placed at the funeral altar surrounding the main altar. The flower spray senders sometimes represent the deceased's social relationships and status or position in communities. The siblings wanted to see the name tags via our webcasting as shown in Figure 5 Left. Before the beginning of the 2nd day,

Takahiro sent high-resolution photos of the funeral altar including the flower senders via LINE, and S4 displayed them on the TV monitor to the siblings.

4.2.3 Face of the deceased and *iei* portrait. After the ceremony on the 1st day, S1 walked up to Takashi and showed his face to the siblings. Then, Takako encouraged the siblings to talk to Takashi via Zoom. A quote from the conversation follows.

Takako: Thank you for attending today. Please give Takashi your voices, I believe he can hear you!

Masami: You worked hard! Takashi's face looks great. He looks so similar to our father. Good luck!

Masako: In our childhood, I piggybacked you many times! (Why have you passed away earlier than me...) I am sorry for that I was not able to see you again.

After that Takako and the deceased's family members sent the other physical attendees off, S2 turned on a Zoom connection to the siblings again on an iPad mini. Takako thanked and talked with the siblings again. After showing Takashi's face again, she tried to let the sisters see Takashi's portrait, his *iei* (a specially prepared photo in Japan that represents the deceased [63, 64]), placed on the altar (Figure 1, Right). However, it was difficult to recognize it in detail via the webcast. Therefore, Takahiro brought another framed portrait for his sisters to see (to which the sisters commented: *What a good picture!*). After that, the sisters said hello to the other relatives, such as Takako's grand children. The deceased's face and the *iei* portrait are one of the most important pieces of information for the bereaved. However, these things are usually hidden on public broadcasts, such as in TV shows, in order to protect privacy. Personally, our staff were initially hesitant to capture these images, but immediately realized that we had to webcast them to the remote attendees for the full experience.

4.2.4 Voices of the priest's sermons and greetings from Takako. The siblings and Takako's friends were not satisfied with the quality of sounds on our webcasts. While they had no interest in Buddhist sutra chanted by the priest, they requested that we allow them to clearly hear the priest when he occasionally explained the meanings of funeral rituals. On the 2nd day, Takako, as the chief mourner, gave the mourners greetings. Though we prepared another microphone for the 2nd day in order to capture better sound, S4 said "We (*people*

in the siblings' house) were able to hear about a half of her greetings." While, F4 said "I was able to hear Takako's greetings. The quality of sound the 2nd day was totally better than the 1st day." Obviously, our sound equipment settings should be improved in our future works. On the other hand, we noticed that there were notable scenes where high-quality sound was especially desirable and many other scenes where good sound quality was much less important. Important sound contents should be identified and delivered in high-quality to the remote attendees by configuring microphone and public-address settings.

4.3 Giving the Deceased Farewell Messages

The remote attendees are not able to hold any physical rituals such as giving floral tributes and performing incense practices (Figure 5 Center). In spite of these physical restrictions, we tried to enable interactive communications between the hall and the remote site, as we recognized the importance of having interactivity between the mourners.

On the second day, after the main rite was held by the priest, the layout of the hall was changed for the final departure ceremony (Figure 2 Right). In the final departure ceremony, the deceased is placed in the middle of the hall before being moved to the crematorium. All physical mourners gathered to surround Takashi, filled the casket with the flowers that were put on the altar, and said their last goodbyes. Takashi was decorated with many flowers, his favorite cloths, and some souvenirs he would take to the heavens. Finally, a cloth, on which bereaved family members wrote down messages to him, was placed on the body. To give the siblings a last look at Takashi's face, S2 got a close to Takashi with an iPhone running Zoom. Then, Takahiro called the siblings as below.

Takahiro: We can now hear your voice. Please talk to Takashi.

Masataka: Takashi, we are really sorry. I personally think that you could have lived at least ten more years! Takako, I believe that you will hold on. We are sorry about not physically attending today. We had to join... Now, I am seeing the TV, and it seems that his face smiles and is really good.

Takako: Thank you very much! I am touching him on behalf of you.

Takako touched Takashi's forehead where the siblings could see. In the interview after the 49 days rite, she emphasized this scene: "I thought that close relative would like to put a hand on the deceased. I wanted to realize this wish. The siblings told on the phone 'we felt as if we really joined the funeral more than we expected.' Without the live streaming, I think that they would have regretted not joining the funeral."

4.4 Substitute of Physically Attending or Unexpected Special Experience

In contrast to the siblings who apologized to Takako for not attending the funeral physically, her friends expressed gratitude at being given an opportunity to join the funeral even virtually. As mentioned, most funerals in Japan in recent years do not invite many attendees beyond close blood relatives. Therefore, the friends did not expect that they would be able to attend the funeral regardless of the COVID-19 pandemic situation.

F4 mentioned "Since I had a long-standing relationship with Takako, I wished I could fly to the hall. On the first day (with the 360-degree system), I was conscious of the bad quality of the video. But on the second day (on Zoom), I felt as if I physically attended. For example, I was able to appreciate Takako's greetings, see the faces of her sons that I know so well, and see the deceased's face. I was really moved by the last scene when a relative remotely called 'Takashi!' and talked with him. This video will become a cherished memory for people familiar with the deceased. I was absorbed in the webcast, leaning forward to the monitor. I wanted to put my hands together. The webcast realized my wish, though I had been sorry about that I was not able to join."

F2 explained how she and F1 had a similar experience on the second day: "In general, we were hesitant to attend the funeral due to needing the wheelchair. That day was especially bad as his (F1's) condition was not good and needed an infusion. Therefore, it was impossible for him to attend the funeral. We put an iPad on a small table attached to his bed. We only gazed at the screen, but it made us feel a sense of immersion. In other words, though it is kind of a weird expression, we felt as if we had attended the funeral more than just physically joining the hall. Around us, there was the rush of everyday life in the hospital, while we simultaneously experienced the funeral—an extraordinary event. There were cases where we rapidly switched between the two. For example, we were quickly brought back to the hospital when a doctor came to examine him (F1). It was a first-time experience for us. But, we believe that there is a great need for systems like this (by many people). The webcast totally made the impossible possible."

Takako's friends are highly familiar with using digital tools, compared to other elderly people [5] due to their involvement with our lab. Hence, their comments might not be representative of other elderly people who wish to join someone's funeral but have difficulties doing so. Yet, we believe that the concept of remote funeral attendance will be of a higher value to the next "digital native" generations who will be more similar to Takako's friends in that they will be familiar with preparing devices, connecting the Internet, and joining funerals remotely.

4.5 Value of the Live Streaming and the 360-degree Recording

In the interview we conducted after the 49th day memorial service, Takako and her sons introduced several interesting stories regarding the reactions of people who viewed the 360-degree video recordings. Takako said "Everyone who physically joined the funeral also attended the 49th day rite. Therefore, the video recordings just remind them of the funeral days. On the other hand, when neighbors visited my home to pray for Takashi, I tried to produce a virtual funeral experience for the visitors by showing them the scene where the mourners were standing up and holding *shōko* (incense tip) rituals [66]. However, I wanted to zoom into a particular position such as the first person's view when a mourner hold a *shōko*. While the high-resolution 360-degree recordings included a huge amount of information, they are not enough yet for the virtual mourners (who missed to join the funeral)." Takahiro introduced a different story "When my close friend who knows my family well came, we also let him see the video. He mostly skipped the boring scenes such as the

priest's sermon and focused on 'good' scenes. I also thought that handheld video footage with the interactive remote communications (even with the limited quality of the video) was better than the 360 recordings taken at the fixed position, especially for (virtually) experiencing the funeral. I think it is a requirement for live (streaming)."

He additionally said "The high-resolution 360 video recordings were very useful for us (the bereaved family) and helped us to precisely recognize who attended the funeral. Since we sat down in front throughout the funeral rites, we were not able to see all of the mourners. We have to send a gift in return for funeral offerings, especially to ones who offered more than others." Due to Japanese funeral customs, the attendees generally left some condolence money at the funeral reception. The bereaved family will personally thank to them for their contributions after funeral. These stories illustrated that the 360-degree recordings (shot at the fixed position as shown in Figure 2) are interpreted as a high-quality record documenting the funeral. However, for it to provide a more immersive experience similar to physically attending the funeral, further technical improvements are required.

Finally, at the end of the interview, they requested us to see how the siblings watched the webcasts and what particular images they focused on during the funeral. We gave them our recordings of the siblings in their home, taken by S4, and the cloud video recordings on Zoom. Obviously, the bereaved family members, physically hosted the funeral, were not able to monitor the condition of webcasting. In fact, there were many of video sources providing a variety of views: our 360-degree live castings, and multiple streaming on Zoom with different angles. The remote attendees were flexibly able to change their point of view. This feedback will be also reflected in future developments.

5 DISCUSSION

5.1 Alternative Style of Funeral Attending for Sincerely Faithful Mourners

Our findings illustrate how this alternative style of funeral attendance will enable people to attend a funeral even when they are unable to physically do so. This is despite our private webcasting—with the original 360-degree camera system and mobile devices with Zoom—being technically sub-optimal in terms of video and sound quality. We argue that our work has shed light on new design directions for alternate funeral formats in the future. Contemporary funerals especially in Japan are not opened to the public and only invite close relatives. The COVID-19 pandemic has promoted this trend, making it more common in other countries as well (e.g., [24, 34]). However, there are many faithful mourners, who would prefer the in-person funeral and hold the traditional rituals, that have been left behind by this tendency. In many hyper-aged societies, including Japan, bereaved family members are often aged and have physical disabilities, as was the case with Takashi's siblings. Since they are eager to attend the funeral and say their farewell to the deceased, there is an obvious design opportunity and need that could be addressed using remote communication or Telepresence technologies.

In addition to allowing for the attendance of those who can no longer attend, online or virtual funerals can expand the range of attendees beyond what would have been traditionally accepted. For

example, attendees could be expanded to include persons who only met the bereaved online. However, even if the deceased or bereaved would want to invite them, it can be challenging to invite "strangers." This challenge is compounded by the fact that the physical size of funeral halls is becoming smaller in Japan and it is impossible to change its capacity flexibly. During the COVID-19 pandemic, virtual funerals have been already conducted in online gamers' communities [10, 12]. These examples suggest that there is a need to discuss whether human relationships forged in the real world and the virtual world should be equally welcome to participate in memorial practices and how technology can be used to support equal participation.

Given this background, we expect that the co-presence of physical and remote attendees will become common in future funerals. Considering this direction, designers must take into consideration the different types of mourners: 1) who should be physically invited, 2) who should be allowed to attend only online, and 3) how should people who do not have well-defined societal roles (e.g., online friends) be classified. A hybrid funeral could—without the limitation of the physical capacity—be widely open to all sincere mourners who would like to pay their respects to the deceased. Attendees would not have to care about existing social relationships which are defined in the physical world.

5.2 Performers in the Funeral with Webcasting

5.2.1 Remote Funeral Conductor (RFC). As noted earlier in this paper, we described that a funeral can be modeled as a "performance" [14] in which all attendees at the funeral play roles. In this case study, some of the authors joined the funeral in a unique and novel role. They participated as both "death workers" [41, 72] who provided webcasting services and also as mourners attending the funeral. We term this unique and new death worker role as the "Remote Funeral Conductor (RFC)." We define the RFC as the death worker in charge of webcasts and Telepresence at funerals. This is a role where one is required to handle digital information related with death between the deceased and the bereaved [6, 17, 18, 45], especially in the stages of the post-mortem interval [41]. As such, RFCs will not only have to learn knowledge of funerals and the human sensitivities surrounding it but will also be required to master technologies for webcastings.

Today, it is easy for anyone to conduct technology-mediated (funeral) webcasts on YouTube, Facebook, etc., even to the public. However, RFC must handle highly sensitive images such as the deceased's face. Such sensitive imagery is usually hidden on public broadcasts, such as on TV. In our work, however, we found that Takashi's "last face" was one of the most important images to be shared among the bereaved family and relatives. Takako's friends, especially F4, also highly appreciated the scene where Masataka remotely gave Takashi his last farewell message. However, as noted above, such highly private and sensitive scene should not be broadcast to the public. This suggests that RFCs are required to carefully consider and handle the contents of the webcast, adjusting the material depending on who the remote attendees are.

5.2.2 How an RFC works throughout funeral. Since multiple performers collaboratively work together to make a funeral possible,

including RFCs, there is a need to consider how RFCs should co-perform with the others in the funeral hall and also the remote mourners. The Japanese funeral consists of the main actor (the deceased) who has already passed away, the priest who holds funeral rites, the chief mourner (and other bereaved family members) who welcomes the other mourners, and the funeral hall staff who support the rest of the cast. Each actor here plays their respective role, sometimes with the use of props (artifacts). For example, the priest uses a set of Buddhist items while all other mourners are required to sequentially hold *shōko* (incense tip) ceremonies. In Takashi's funeral, our staff (S1-4) also physically existed as RFC who ran the webcasting and recording equipment. However, all other attendees interpreted them to be the same as the other mourners. This is despite their functional role being closer to stage assistants like *kuroko* in *kabuki* stages. We (S1-4) had to monitor the system to ensure it was working correctly and resolve many technical troubles. At the same time, we had to perform as attendees and held the *shōko* rituals as well.

In future technology-mediated funerals, webcasting equipment and the RFCs might be hidden behind the other mourners and more user-friendly designs—which is operated by the bereaved family members—could be prepared. However, the bereaved family is often very busy performing their original role throughout the funeral and are unable to webcast or record the ceremony themselves. In this study, in fact, we were required to consult the bereaved family members, relatives, and funeral hall staff prior to the funeral days to arrange our attendance. Furthermore, we needed to provide full-time support to the siblings. In other words, it took much time and effort for us to forge trustworthy relationships with all stakeholders and received permission to have our staff present at the funeral. Both our staff, as RFCs, and equipment needed to be accepted by the bereaved family and all other mourners.

Regarding these aspects, we summarize this discussion. The technology-mediated remote funeral are performed by a variety of actors: remote mourners, physical mourners (the bereaved family and others), the priest, the hall staff, and the RFCs. However, the RFCs (sometimes engineers) working for funeral webcasting have several other roles. First, they may need to act as gatekeepers, managing the security settings and determining what types mourners may join. They may also be interpreters and planners, carefully talking with the bereaved family members and considering what kind of private and sensitive scenes will be shown. Finally, they may also be required to perform as ones of mourners while operating the equipment since they are also on-site at the funeral.

5.3 Implications for Designing Technology-mediated Funerals

5.3.1 Live webcasted images and other information. Due to limited Internet data capacity, the resolution of webcasted videos is restricted. This is especially problematic for 360-degree camera footage. While these cameras are convenient as they offer the viewer fully independent control of the camera angle, they require significantly more bandwidth than a typical 16:9 video stream. Given this limitation, designers working on developing the funeral webcasting experience will need to consider how to efficiently transfer information from the funeral to the remote attendees. As noted in

our findings, the siblings sometimes wanted to know things which could be described as literal data formats instead of through video footage. For example, they wanted to know who attended the funeral (a list of attendees) and the names of people who sent flower sprays. At the same time, we also noticed that the remote viewers were sometimes satisfied with fixed cameras views (e.g., when the priest held a set of funeral rites) but appreciated a more mobile and flexible perspective in other important scenes (e.g., when saying their last farewells). The designers will be required make appropriate use of multiple media channels and layouts, balancing the pros and cons of each.

5.3.2 Roles of live webcast and recording. In this research, there were multiple media sources: 1) our original 360-degree webcasting system, 2) 2D webcast sources streamed via Zoom from fixed and mobile positions, and 3) the high resolution video recordings 360-degree. The image quality was limited on 1) and 2) but were available as live broadcasts, while 3) vividly recorded the all parts of the funeral hall but require a huge amount of time to browse. According to the feedback from Takako and her sons, we found that 3) was interpreted as a set of high quality records but not as a medium through which viewers could experience the funeral vicariously. Even if 1) could be improved to provide higher quality footage with sounds on a level similar to what was captured with 3), we might argue that 2) is still better than 1). This is because 2)—making use of traditional cinematography methods [31]—can immerse the mourners in the funeral attendance experience and other memorial rites. Some researchers exploring Telepresence applications have argued that there are significant challenges with properly setting up 360-degree cameras for remote collaborations [49, 60] and discussed how to guide user focus in 360-degree videos [35]. Our findings also led to implications for designing remote or virtual experiences of holding memorial rituals. These embodied rituals are gaining support from recent research works, such as some interactive works (e.g. [20, 64, 70]), but the issue of how to produce a first-person experience for mourning and memorialization is a topic that will need to be considered in the future. This will be highly relevant to and will likely need to take advantage of Telepresence/Telexistence and other Virtual Reality techniques.

5.3.3 Presence exchange between physical and remote attendees. The transfer of presence is another research question which is continuously discussed in the Telepresence and Telexistence research community (e.g., [33, 58]). Our findings included some items which were related to this topic. The funeral consists of many kinds of presences performing many different roles: the deceased, the chief mourner, the bereaved family members, the other mourners, the priest, the staff at the hall, the technical staff (the authors), and the remote mourners (the siblings and the friends). Though we did notice that the presence of remote persons occasionally manifested in the hall and vice versa, the presences of all participants was not always fully realized both in the hall and the remote locations.

Designers working on remote funeral attendance will be required to manage the presences and properly configure how presences are exchanged between two remote locations. When the priest held the set of rites, for example, both the physical and online attendees were silent or required to hide their presences as much as possible. When all physical mourners held *shōko* rituals, they temporally

showed their presences. Remote mourners were unable to show their presence in this case due to the physical dependence of the ritual. However, when the hall staff asked all attendees to put hands together to pray, the remote attendees were able to participate in the ritual (though they were not recognized to be doing so by people at the hall). During the last farewells—when Masataka with Masako and Masami interactively said their last messages to Takashi—all attendees vividly recognized and highly appreciated the remote attendees' presences. As argued in previous studies, spiritual rites, such as funeral ceremonies, compel participants to perform physical ritual actions [53, 64, 66–68]. It is mandatory for the designers to understand the need for these elements, appropriately manage several kinds of presences, and prepare physical rituals that can be equally held by online and onsite people.

5.3.4 Crossing point of technology, religion, spirituality, culture, and death rituals. Any design direction for developing remote funeral attendance experiences must consider spiritual thoughts and manners, and contemporary death rituals that are often unique to a locale. In addition to the COVID-19 pandemic, which suddenly affected the customs and manners of funeral attendance around the world, several social changes (e.g., the secularization) and emerging technologies have been shifting death rituals over the last decade [2, 16, 32]. Thankfully, in Takashi's funeral, held just after the state of emergency was announced by Japanese government, nobody—including the Buddhist priest and the funeral hall staff—complained about our webcasting and recording activities. It is possible that somebody would have objected to our activities under normal circumstances, especially when we put the iPhone closer to the deceased's face, citing our activities as bad manners. We expect that we were given special permission given the special circumstances of the time (i.e., the COVID-19 pandemic).

Techno-spiritual practices [4, 74] were initially defined as the technology-mediated religious practices (e.g., [8, 13, 73]). Meanwhile, death rituals, including funeral, have deep roots in local traditions and religion, and have been passed down over long histories from times when technology we have today was not yet available. However, just in recent decades, some of funeral business operators have adopted digital technologies [38, 63, 69], and most of them are now forced to provide webcasting services [34, 44, 47, 55, 75]. In the case of supporting remote funeral attendance, the designers are required to consider techno-spiritual practices, thanato-sensitive designs [39, 40], including ones use interactive techniques, and Telepresence and Telexistence researches. Practically, designers and system operators have to manage and coordinate people's presences at the funeral, the social and cultural aspects defined by religions and the society, and people's requests for contemporary funeral rites.

5.3.5 Impact of cultural differences on funerals and the role of death workers. While Moncur et al. [41] described how death workers, such as funeral directors, utilize technologies in the period immediately after death, the post-mortem interval (PMI) in the UK, we find this framework difficult to use as-is since the processes and intervals are different in Japanese culture. In Japan, the bereaved family must work hard to prepare the funeral just a few days after death, without any advice from a funeral director, as is common in Western countries. This makes it difficult for the bereaved to integrate new

technologies and services into their funerals, especially services which are not offered by funeral service providers. This highlights a limitation of our case study. Due to the heavy cultural dependence of the subject matter, our findings reported herein may not be generalized to be globally applicable. However, we can, at least, note that the designers should understand cultural differences and propose culturally appropriate technology-mediated death rituals in future works.

6 CONCLUSION

This paper described a case study where the authors webcasted a person's funeral to his siblings and his wife (the chief mourner: *moshu*)'s friends with our original 360-degree Telepresence system and mobile devices running Zoom. The webcasting session also included the recording of funeral rites as high-resolution 360-degree videos for post-funeral viewing by the bereaved family. Unfortunately, we faced several technical difficulties during the two days of funeral rites, and mobile webcasting via Zoom ended up contributing more to the remote attendance experience than our 360-degree Telepresence system. Utilizing the mobility and the interactivity of the Zoom webcasting, we provided a funeral attendance experience to the deceased's siblings, allowing them to feel as if they physically attended the funeral and give their younger brother their final messages. Throughout the webcasting, we had to manage the "presences" of both remote and physical mourners, the Buddhist priest, and the staff at the funeral hall (including ourselves). One aspect of this was allowing the remote mourners to talk with the physical mourners. After the funeral, we conducted interviews with the bereaved family and the chief mourner's friends, to receive feedback on the remote attendance experience and the 360-degree recordings.

From the webcasting experience and the interviews, we found out that the normal 2D webcasting on a mobile device—which allowed the operator to focus the field of view on an object—provided a more immersive experience to the remote mourner than the high resolution 360-degree video records shot from the fixed position. From our findings, we came to the conclusion that, after the COVID-19 pandemic, funeral and other death rituals will have to be integrated with technologies especially related with remote communication, Telepresence, and Telexistence techniques. Research into techno-death rituals will overlap with existing research directions currently discussed in the HCI community such as techno-spiritual practices, interaction designs for mourning and memorialization, and thanato-sensitive designs. In this paper, we finally listed several implications of our findings for designing techno-death rituals. However, these are still only theoretically defined. Future work will explore concrete design cases and develop systems for supporting techno-death rituals.

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