Remote Conference Participation in Social Virtual Worlds

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ABSTRACT

Scientific conferences have long had issues with access by people without the time, money, or ability to travel. Coupled with a renewed focus on sustainability, driven by increased attention to the environmental impact of air travel, academics are looking again at online and virtual conferencing as one part of a solution to these problems. Over the past year, we have experimented with the Mozilla Hubs social virtual environment (SVE) platform to explore solutions to this problem. Our experiments have focused on leveraging live video streams of talks at traditional conferences, such as ACM CHI, ACM UIST, and IEEE VR, as the basis for creating remote experiences. While the focus has been on co-watching these live streams of the conference talks, we have experimented with casual social chat spaces and online distributed poster sessions as well. A user study was at the UIST 2019 conference focused on understanding social interactions, user experience, design aspects, and motivation of attendance, and we are using lessons learned from that study to run a larger experience at the VR 2020 conference. The UIST student showed that SVEs offered a reasonable experience for co-watching the conference talks remotely and attending the virtual poster session. In this position paper, we summarize how we are building on the lessons learned for IEEE VR 2020.

Index Terms: Human-centered computing—Collaborative and social computing systems and tools—Virtual Reality—

1 INTRODUCTION

Over the past year, we have experimented with using social 3D virtual worlds to augment traditional academic conferences with synchronous online social experiences for people who cannot attend in person. While conferences are viewed as the place where experts come together with their peers to share new ideas and begin new collaborations [6], only a small fraction of academics in any field can attend. Many factors influence whether a person can attend a conference or not, including personal circumstances, health and mobility, costs, accessibility, and safety of the location [10]. For some, it may not be possible to get a visa to attend [7]. Researchers at institutions in poorer countries may be especially impacted by these factors and are, therefore, underrepresented compared to those at institutions in wealthier countries [12]. Beyond these barriers, the carbon footprint of attending international conference is primarily driven by air travel, and is a growing concern in the academic community. [2, 4]. Researchers sometimes choose not to attend a conference even if they have the resources to do so because of the negative effects of air travel on the environment [12].

Academic conferences are commonly structured around the presentation of research findings by the scientists or academicians, the opportunity to attend workshops, and use the opportunity to network with other researchers or maintain existing relationships [6, 12, 17]. Many academic conferences are starting to record and live-stream video of the presentations, making them available synchronously with the conference and afterward. Leveraging these streams and using virtual environments to co-watch the conference presentations remotely is an obvious starting place to improve accessibility and offer a sustainable alternative for future some international conferences and long-distance meetups. This idea is not new, is finally becoming practical for mainstream conferences. Online conferences, such as the Open Simulator Community Conference, have been running regularly using similar technology for many years, as have other online events. But these approaches have not been seriously considered as even partial replacements for the vast majority of academic conferences. While we do not expect that virtual conferencing will replace in-person conference attendance in the near future, this research demonstrates that it can be a viable alternative for researchers to gain some of the benefits of attending international conferences when they cannot (or choose not) to attend in person.

Beyond access to local content (such as video streams of the presentation), the lack of availability of easy to use platforms that can be tailed to the needs of academic conferences has limited the feasibility of creating these experiences. Older platforms (like SecondLife) and modern social VR platforms (like VRChat, Recroom, and Altspace) are closed (so they can't be modified) and aimed at more open, social uses. Most systems require users to use their existing accounts on those systems (which they may not wish to use in a professional context) or create and manage new ones, and accepted the terms of service of those platforms. In our work, we have been leveraging the open source Mozilla Hubs (Hubs)[1] platform, which works in (almost) any modern web browser on most modern equipment, from phones and tablets to laptops and desktops of all kinds; it supports 3D-in-a-window on 2D screens, and fully immersive VR on standalone and PC-connected VR devices. Hubs supports adding a wide variety of network-accessible media to the virtual spaces, from video recordings and streams to images and audio to PDFs and 3D models, and allows users to share their screens or cameras with the rooms; taken together, these support a wide range of presentation and collaboration opportunities. Participants are represented as avatars inside the virtual environment and can communicate through voice or text chat. Compared to previous research, the setup barrier is significantly reduced since the Hubs rooms can be entered by clicking a web link, and does not require further software installation.

Initially, we are examining the potential of Social Virtual Environments (SVEs) like Hubs as one way to gain the benefits of attending conferences by offering virtual conference rooms where people can co-watch the paper presentation live streams in real-time. Previous research has shown that watching videos/live-streams together with others in a virtual environment can foster relationships between peers and make the experience more enjoyable [18, 20, 22]. We conducted a user-study of this approach at the ACM User Interface Software and Technology conference (UIST) as part of the official "Remote Experience"[2] program [11], including a small virtual poster session, where non-attending co-authors were recruited to present their posters in Hubs. Based on this experience, we are running a larger online experience at the IEEE VR 2020 conference in March and should have initial results before this workshop in April. In this paper, we summarize the results of the ACM UIST study, and give an overview of our plans for IEEE VR.

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[1] https://hubs.mozilla.com
[2] https://uist.acm.org/uist2019/online/

2 Related Work

2.1 Carbon Footprint of Science

The acceleration of global warming over the past decade has brought renewed attention to the carbon footprint of academic conferences, including travel, energy consumption, and waste production. Achten, Almeida, and Muys [1] highlight how choosing not to attend a conference can significantly reduce a person's carbon footprint.

In 2014, Favaro talked about the need for "a carbon code of conduct for science" that requires researchers and scientists to keep track of their carbon footprint, and try to minimize their emissions or purchasing reputable carbon offsets to mitigate their impact [9]. ACM SIGPLAN took up the ideas in Favaros' article and requested that all ACM conferences publicly report their carbon footprint and offer solutions such as carbon offsets to mitigate emissions [16]. ACM UIST 2019 adopted many of these ideas, helping attendees find reasonable offsets, using sustainable materials, offering plant-based meals and breaks, and supporting the ACM sustainability initiative by offering a remote experience. Our goal (shared by others) is to make remote attendance more effective so that it might be adopted by many conferences.

2.2 Social Virtual Conferencing

In 2011, researchers at IBM experimented with a virtual version of IBM's yearly company conference [8]. They conducted a fully virtual version of the conference in Second Life and evaluated the experience. Their study highlighted the difficulties with using this particular technology, specifically issues with setting it up, audio, server lag and application crashes. Most users had to find workarounds to get things going - for some it was so difficult that they couldn't participate [8]. A web-based solution (such as Mozilla's Hubs) mitigates some of these issues, since it runs in standard web browsers and has minimal barriers to entry. Lag and scalability are still issues, but current limits can be designed around by (for example) creating multiple parallel rooms for each session or activity. Hubs also offers avatar customization, lets users pick the names associated with their avatar, easy movement, flying and teleportation, support for a wide range of media, and spatialized audio.

Shirmohammadi et al. used the web.alive[3] tool from Avaya to allow people to remotely attend the Massively Multiuser Virtual Environments workshop in 2010 [19]. The results highlight that remote participants valued the option to participate remotely as most of them were unable to attend in person.

Neustaedter et al. [15] tested the use of telepresence robots for remote conference attendance, and ran them for a many years at CHI. Attendees with accessibility issues felt especially empowered because they were able to experience more of the conference then they were used to. Additionally, participants felt more immersed compared to traditional video conferencing methods. A similar feeling of empowerment and immersion also occurs inside of VR with the difference that the experience in VR is entirely virtual, and therefore reduces the overhead for the conference host in managing those robots. One big open question is how to enable virtual participants and local participants to interact. In both cases, the physical conference is the primary focus; telepresence robots try to bring remote participants directly into the event, where VR excels at creating a social experiment among the remote participants.

Campbell et al. [5] compares VR conferencing with traditional video communication software (Skype for Business[4]). Virtual conferencing increased focus and engagement, and females reported not feeling judged based on their appearance. VR conferencing could, therefore, become a legal requirement to promote gender equality [5].

[3]https://support.avaya.com/products/P0942/avaya-webalive

[4]https://www.skype.com/de/business/

3 Preliminary Experiments

As previously mentioned, our experiments leverage the Mozilla Hubs SVE platform [14]. Hubs is a web-based application that features the creation of 3D virtual rooms in order to communicate with other people virtually. The rooms are private and only accessible through the link that is generated by the room creator. Users are represented as avatars of which the appearance can be selected from a variety of different pre-generated avatars. Hubs also supports fully customized avatars with animations that are created with 3D modeling tools like Blender[5]. Furthermore, the users have the option to load objects like 3D models, PDFs, websites, or YouTube[6] videos into the scene to share it with others. They can also embed video streams from sites like Twitch[7], a key feature for this project. In addition, there is a camera object built into Hubs, which allows users to take selfies or pictures of the virtual scene.

The main advantages of Hubs is that it is open-source (so it can be enhanced if necessary), and its cross-platform compatibility allows users with a smartphone, tablet, head-mounted-display (HMD) or desktop PC to interact with each other in the same environment. When used on an HMD, Hubs will allow entering the 3D world in VR mode, which creates an immersive experience. Another advantage is the integration with the Discord chat application. Discord is similar to Slack, but has more elaborate features for roles and moderation; hubs rooms can be configured to only allow entry to users with access to a certain discord server. The integration is accomplished through a Discord bot, that also adds other capabilities such as bridging chat between a Hubs room and a Discord channel. The bridge shows enter/exit events in the hubs room as messages in Discord, shows all media elements brought into the room (or created in-room using the camera), and so on. This simplified analysis of room activity by processing the channel history.

We also created a second Discord bot that we used to verify conference registration (we asked users for their Discord ID when they registered for the UIST online experience, and only allowed those ID's to join the server), and added a command user's had to type at the end of the tutorial (in the hopes that by having to go through a short tutorial they would have a basic level of familiarity with Hubs before taking part in the experiment.) Unfortunately, forcing users to go through a tutorial, and relying on those unfamiliar with either Hubs or Discord to follow a sequence of steps to gain access added too much friction to the process, frustrating many users.

3.1 Virtual Room Design

Prior to UIST 2019, we created Hubs rooms for co-watching streams at VR 2019 and CHI 2019, used informally with friends and colleagues. For UIST, we took what we learned from those experiences, and from related work, the affordances of Hubs, suggestions from members of the Hubs team and the Hubs community, and the opportunities available with the UIST conference, to design three kinds of rooms: a tutorial room (*Figure 1*), and co-watching area (*Figure 2*), and a poster room for the virtual poster session (*Figure 3*).

Past research has shown that tutorials are fairly important in the area of games, especially in VR [21], where input systems and controls can vary in many different ways [13]. Hubs is comparable to 3D games since it uses mechanics from first-person games, such as movement controls with keyboard and mouse on 2D displays, and teleporting in VR. These controls might be familiar to gamers, but in a conference environment, most of the participants come from a professional background and may not have previous experiences with 3D games. The tutorial room walks new users through the controls and features of Hubs prior to attending the conference, as

[5]https://www.blender.org

[6]https://www.youtube.com

[7]https://www.twitch.tv

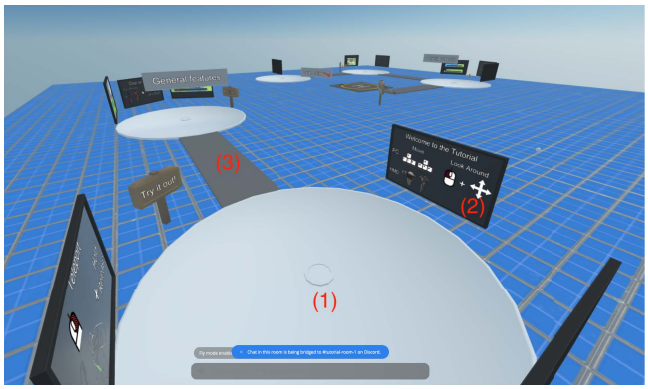

Figure 1: Screenshot of the first section of the tutorial room in Hubs. This section is the starting space when entering the tutorial room and shows the following elements: (1) section platform; (2) instruction screen; (3) road, that connects different sections.

shown in *Figure 1*. Overall, attendees who took the tutorial rated it highly, and other Hubs users have since remixed the room and are using it for their own meetups. We will be using a version of this room in future events, but will simply point interested users at it rather than requiring users to take the tutorial.

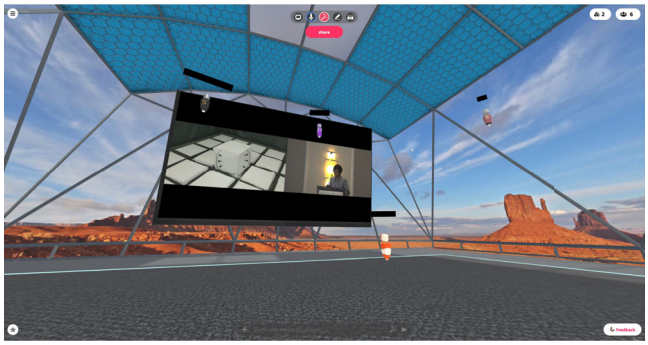

Figure 2: Screenshot of the co-watching area in Hubs. This space is used to watch the conference live streams.

The co-watching room is the main environment for the remote experience, where attendees are able to co-watch the paper presentations of the conference. It features a large space to watch the live streams on a large screen that is positioned mid-air at one end of the room, as shown in *Figure 2*. The large screen made it possible for a variety of users to view the stream without interfering with each others view, but flying up to a preferred vantage point. The large screen had some downsides, however. Because it was so high, it required users to fly. The size meant users complained that the space felt barren, that they weren't sure where to watch from, and that it was awkward to approach others to chat because they didn't otherwise need to be close. In our upcoming experiments, we'll use a slightly smaller screen so that users are closer together, and create viewing platforms that give users examples of good viewing locations without requiring them to fly to arbitrary viewpoints.

UIST had two parallel tracks, so we had different rooms for each of the two streams. Since a single room can only hold at most 20-25 people (depending on the power of a user's computer), we create four duplicates of each of these two rooms. The number of rooms also led to the feeling of sparseness, since it was not possible to tell how many people were in a room before joining.

For UIST, we recruited four poster co-authors who were not attending the conference to come to the remote conference and present

Figure 3: Screenshot of the poster session room in Hubs.

their posters virtually during the same time slot of the local conference. *Figure 3* shows the poster walls that are positioned in opposite corners of the room, creating distance between the presenters to mitigate overlapping audio from multiple people talking at the same time. There were two poster rooms, with two posters each; we split them up (as above) because of the limit of around 25 people per Hubs room.

To support significantly more posters, We would need to have a lobby with links into all the poster rooms, showing the current occupant count of each room. Within the rooms, we would probably only need next/previous links, as this would encourage visitors to choose a less-full room to start, but then travel from room to room in sequence, to see all the posters and to (hopefully) keep the load balanced. We do not know yet how many non-attending co-authors will want to present at VR 2020, but the conference has over 200 posters, so we expect a larger number. In addition, travel restrictions due to the Coronavirus are preventing a significant number of authors from attending (either because they live in countries like China, and can't get a Visa to visit the US right now, or because their companies or universities are asking them not to travel to conferences).

4 Initial User Study: ACM UIST 2019

In [11], we report on the results of the study of the UIST experience. The purpose of this study was to evaluate the opportunity of using SVEs as an alternative to attending research conferences remotely. We asked respondent about their experience with Hubs, but also their motivations for attending the conference (either onsite in New Orleans, or online), and if the experience met their goals. We cannot summarize all the findings here, so we encourage interested readers to read that paper.

A total of 155 people registered for the remote experience, which 22 registrations were removed (either because they were duplicates or because the participant declined to participate in the study). While we opened the Discord server to local registrants to use for local chat, few of the local attendees joined, due to both the friction of joining, but also because most academics do not already use Discord (in the future, we will use Slack and forgo the tight integration). In the end, 111 were remote attendees and 26 were local attendees joined the server. Across all three days of the conference, 64 users entered the *Co-Watching Rooms* and have spent 37 minutes inside on average. 73 users visited the *Tutorial Rooms* and spent 17 minutes inside on average. The *Poster Rooms* were visited by 34 people in total with an average time of 19 minutes per user.

4.1 Discussion of Study Results

Overall, the remote experience was successful and offered a reasonable alternative to attending the conference in person. Most participants reported the experience met their goals to learn about new research they haven't heard of before. Attendees who physically attended the conference reported greater connection with others

compared to remote attendance. However, the remote experience did offer a reasonable alternative on many of the dimensions we asked about (discuss new research with others, meeting new people, speaking with existing or potential collaborators at the event). With the same social criteria in mind, only one of the Twitch respondents reported being able to accomplish those same objectives. Hubs was able to outperform Twitch in nearly every social condition. One explanation would be that the social interactions on Twitch are limited to the chat or social media, which present challenges to discussions about research [3].

The remote participants appreciated being able to attend the conference remotely, on any device, which was also reported by [19]. One person has attended some of the virtual conference sessions on a phone on a train and said: *"This is a surprisingly good-quality way to remote attend!"*. The analysis from the feedback data shows significant interest in attending remote conferences again, with attendees reporting a willingness to pay between 25$ to $200 for a similar future event.

There were additional details in the paper about different motivators for attending a conference between remote and physical attendees, but with our small numbers they should be taken with a grain of salt. We also found that the Hubs rooms were overall quite satisfying, but need further improvements to be used in situations like this. A number of the issues we found have been fixed since last year, and we have been working with the Hubs team to ensure a greater alignment with the needs of large-scale online meetings. Many users were impressed with the streaming quality of the talks; both ACM UIST and the upcoming IEEE VR conference used high quality setups for capturing the output from the presenter laptops and insetting a video of the speaker, which made a huge difference in quality. In contrast, when we tried this with CHI 2019, the quality of the streams was so poor that it was often impossible to read even the largest text elements on slides.

The data also indicated that participants felt involved and immersed in co-watching the talks through Hubs as if they were watching the talks in the conference hall in person. The visibility of local viewers on the stream (in the camera view of the presenter) or other remote participants in Hubs contributed to this sense of being involved. For example, one person mentioned that she had to itch her head when she saw a man itching his head on the stream. Similarly, another person mentioned that during a Hubs selfie, he realized that he was smiling in real-life for the picture, although the image was taken virtually. There seems to be a correlation between certain virtual actions and the persons' virtual presence that can trigger subconscious real-life behavior, as has been noticed by social VR researchers over the years.

Beyond passive co-watching of the talk videos, we ran a small (4 presenters) virtual poster session. The quantitative results indicate that the majority of the participants were very satisfied with the overall experience of the poster sessions in Hubs. Most participants felt they could socialize and connect with presenters and others, although audio issues with some of the presenters caused problems for some participants. With this sense of be co-present inside the virtual world, real-world social issues (such as personal barriers) can interfere with the experience. One of the the poster presenters mentioned that it was just as awkward as a real-world poster session for them to try and engage people into their poster while also trying not to annoy them if they are only planning to look at it.

5 Current Work: IEEE VR 2020

We plan on continuing to evolve and expand our use of online social virtual worlds over the coming years. We are running a formal experience at IEEE VR in March 2020, which will will have initial results from before this workshop. Beyond that, we hope to do run ad-hoc setups at conferences that stream video of the talks, including ACM CHI 2020. We are hoping to do more formal engagements with ACM UIST 2020 and IEEE ISMAR 2020, at least, and are discussing possibilities with non-CS colleagues in the various "FlyLess" movements (e.g., in climate science, geology and so on).

The biggest change between UIST and our future projects, like IEEE VR, is scale. We are advertising this experience far in advance, and using the main conference registration system to register: this is less "academic experiment" and more "future of the conference experiment."

Many of the friction points we experiences with UIST have been eliminated. We will be hosting a custom hubs instance on hubs.ieeevr.online, which will support a simple login flow that does not require the use of Discord (a major pain point at UIST); we will use the Discord integration for management and moderation, but will switch to Slack (much more comfortable to academics) for in-conference chat. We are evolving our room designs to suggest appropriate viewing locations, as our open-room setup in UIST led to people selecting good viewing points for themselves and blocking the view of others when they position themselves in front of the screen. More importantly, Hubs now makes it easy to "inspect" media elements (like video screens, or poster images) so that anyone can get a "good" view of the streams or posters without having to position their avatar in front of others. It will be interesting to see what sorts of social protocols arise, and if this interferes with understanding what others are doing just by looking at where their avatars are positioned.

One limitation of Hubs that has not changed is that any room only supports up to approximately 25 people. The limitation is a function of the client computers; in hubs, each person sees and hears all other participants, so each addition person in a room adds another avatar and another voice stream for every participant. Moving from one room to another is as simple as following a URL, but there is more friction than we'd like. One positive aspect of this limitation is that keeping the groups under 20 is a benefit from a noise and distraction viewpoint; too many people, in spaces without existing social norms, stands a good chance of being unusable (as people chat, forget to mute their mics before typing, and so on). Hubs will likely evolve to more directly support larger groups, perhaps with roles and asymmetric capabilities, but for now all spaces have all users as first class members. Hubs does allow any number of people to remain in the lobby and observe the room, with the ability to text chat, but feedback from conference attendees was they preferred to be inside the space.

We are evolving the room designs based on other ideas from the UIST experiment. Because our Hubs instance can be modified, we are planning to embed clocks in all rooms that show the current time in Atlanta, so remote participants in other time zones are aware of what time it is at the conference (this was an issue mentioned by participants at UIST). Similarly, we are working on creating a dynamic schedule display within each presentation room, by keeping a JSON representation of the schedule and rendering the information for each session automatically based on the time.

For remote participants with good network connections, we also plan to host rooms that will show all three video streams from the conference at once, with audio being limited based on location (so the sound from only one talk is audible at a time, depending on where you are standing). When combined with the media inspection feature mentioned above, these rooms would make it easy for participants to check in on different talks with no friction, and represent one way the remote experience may actually surpass physical attendance.

We hope to host a much larger virtual poster session at IEEE VR. We will still focus on running the virtual poster sessions synchronously with the physical on-site poster sessions, as our current work is primarily focused on "remote attendance" vs "distribute conference". However, this may change at the last minute: travel is-

sues arising from the Covid-19 virus are pushing us to allow remote presentations of papers and posters, and at least two Universities (one in Australia, one in New Zealand) is considering gathering local researchers together and having a local "site". The time zones are 12 and 16 hours off of Atlanta, so it will be interesting to see how those experiences evolve. We will know more before the workshop.

Finally, beyond hosting synchronous events with the conference, we are considering other online-only activities for remote particpants. One example is coordinating Birds-of-a-Feather meetups. Space is essentially unlimited in the virtual world, so there is no limit on the number of meetups we could host online. And with no physical/local equivalent, the meetups can be hosted at whatever time the organizers choose. Our current plan is to offer the option to registered online attendees to organize a meetup. For example meetup, we will create a hubs room for them, give them organizer(s) administrator privileges for that room, and add their meetup to a schedule page. Our only requirement is that all meetups happen when no online activities (talks, poster sessions) are happening synchronously with the conference, so that attendees are not forced to choose.

6 Conclusion and Future Work

In this research, we are interested in exploring the potential of SVE platforms to support remote attendance at scientific conferences. In the near term, we hope to enable remote particpation in events that are still primarily designed as single-site in-person conferences. While such online experience may offer less of the in-person social experiences of traditional conference attendance, they provide many of the benefits of a conference people who cannot or choose not to attend, whether for personal, financial, or climate impact reasons.

As the underlying technology improves, SVEs may go further, offering significant potential for future virtual gatherings that can potentially replace face-to-face meetups, or allow them to be dramatically re-conceived. Supporting virtual conference attendance offers a solution to both the issues of sustainability and accessibility of scientific conventions. As the goal of reducing the global carbon footprint continues to become more urgent, a shift towards virtual communication technology seems inevitable, and environmental awareness may act as a catalyst for these projects to proceed.

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