Reel the Real: Navigable Virtual Gatherings on the Web

Sanchit Sinha (ss7mu)   **Gaurav Jindal (gj3bg)**   **Arijit Pande (ap6bd)**

Rishab Bamrara (rb6xj)   **Akhila Ranga (ar8aq)**   **Akhil Peddireddy (ap3ub)**

ABSTRACT

The COVID-19 pandemic resulted in an unprecedented switch to virtual gatherings. Tools like Zoom, Slack, Teams etc, which were originally designed to support the one-to-many group meetings, had turned out to be a way for all the virtual meetings. This demanded a need for a video conferencing tool that focus more on providing in-person feel to cater to the specific large gatherings like conferences and career fairs. We propose Reel the Real, a web based application which helps to solve this need, through a navigable virtual room with proximity based communications. We did a user study to evaluate the system we built and derived insights which shows that users are more likely to prefer our application for many-to-many gatherings with no privacy concerns. This is one of the first works to study the usability of web-based navigable virtual gatherings that need no sophisticated devices. Our code is available here. [1]

INTRODUCTION

Due to COVID-19, there has been an increasing need of social distancing and remote work, resulting in virtual instead of in-person gatherings. Current state-of-the-art video conferencing tools utilized to hold such events (such as Zoom, Slack etc) lack the specific types of interactions that are integral to the in-person conferences and gatherings, such as talking with peers on-the-go or spectating different conversations. Due to the one dimensional nature of many of these virtual interactive tools and their limited functionalities to interact in multiple groups, there might be a drop in productivity of the users [8]. Simple video interactions can often get tiring - phenomenon such as zoom fatigue are real and have severe consequences on individual performance. There can also be a risk of losing the feeling of belonging to an organization [6]

In particular, the spatial navigation across the groups is not possible in the current widely used video conferencing tools. The virtual rooms do not provide the same feel and experience as a real in-person room. Moreover, the participants in one room do not have any control over the discussions happening in other virtual rooms. If a participant wants to talk with others privately through audio or video channels, there currently is no way to directly initiate this type of conversation. Hence, a tool which helps in spectating & swiftly switching between conversations, and navigating the events in a room like environment will be ideal and can potentially make up for the in-person aspect of many of these events in the future. It will also help in making the gatherings more interesting and will aid the participants in maintaining focus and boosting their productivity.

The existing tools like Zoom are specifically focused and designed to cater towards a one to many group meeting format, hence lacks the desired features for a more real life in-person conversations. For instance, currently the only way to do this in Zoom is to create separate breakout rooms. However only the host can do that and the participants have no control over creating these rooms, and there is no way to listen in on other breakout rooms simultaneously. Prior work in this field [2] has underlined the acute need for a more real-life experience in research conferences. We believe that not only the research conferences, but also the big tech events such as WWDC or CES, career fairs and likewise can also benefit from such a solution. In this work we would like to a propose and investigate a solution which we call it "Reel the Real" to answer the following question -

"Would a new video conferencing tool which enables navigation in a room like environment via a virtual avatar imitating physical space and allowing video communication based on proximity, provide a better experience in emulating a more real life environment in big conferences/fairs?"

RELATED WORK

The idea of online synchronous multi-participant navigable rooms are quite popular in the the gaming domain. Steinkuehler [10] did a first of its kind study on the application of Massively Multiplayer Online Games (MMOs) in the area of collaborative education. This research explores cognitive ethnography and presents the qualitative results of the impact of MMOs, especially those with an explorable virtual world. It turns out that this kind of environment makes collaboration more fun and accessible to everyone. The author's argument is that it supplements the classroom education and allows learning in a rather relaxed environment. Another study by Kleiman et al. [7] posits that playing games can create a common object with shared goals, which can give players the feeling of being in the same environment, belonging to the same organization, working on joint objectives, and give an enjoyable experience. This motivates us to explore this concept of multi-participant navigable rooms to solve the problem stated in connection with social interactions during the COVID-19 pandemic.

There have been several efforts leveraging Augmented Reality and Virtual Reality to implement this functionality of spatial interaction and collaboration [4]. Jones et al [5] introduced a new two way system called VROOM where the local user can see a life-size avatar of a remote user through AR while the remote user has a head mounted VR interface that tracks hand movement and pose of remote user which are applied to avatar. This 360° view of local space allows more realistic interactions or meetings. The VR based applications

---

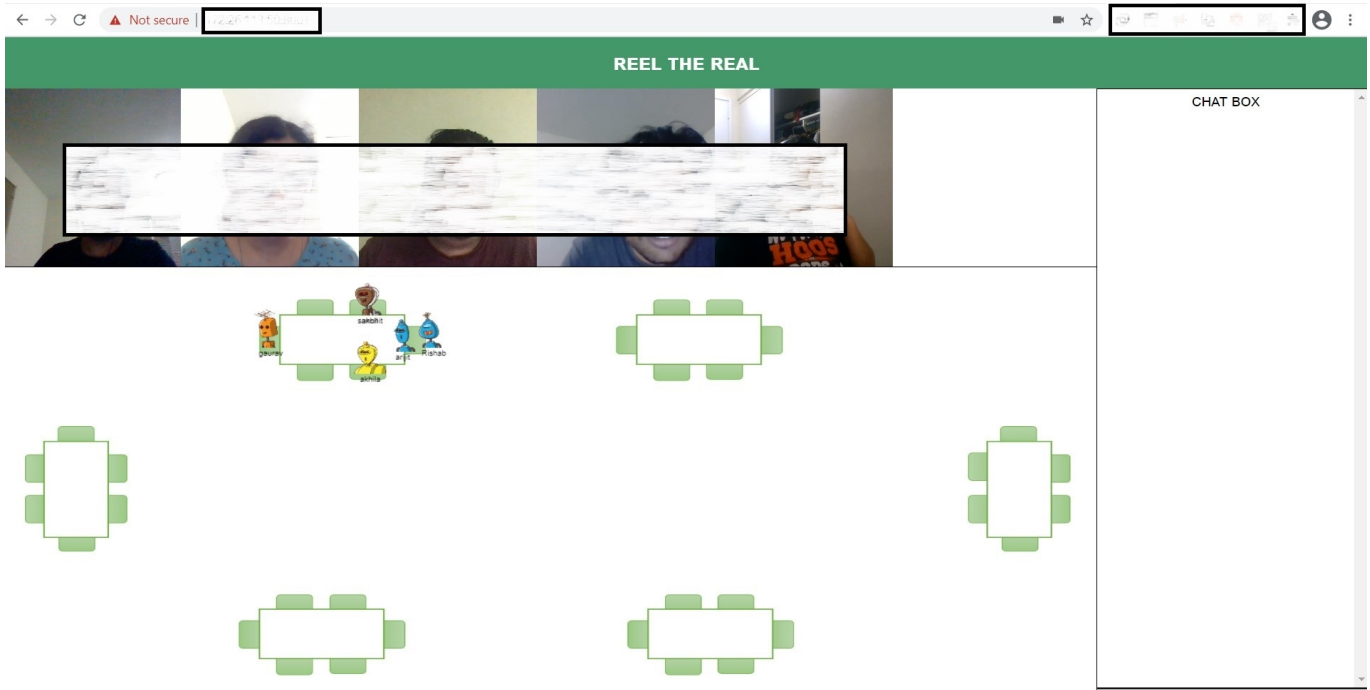[1] https://github.com/jindal2309/hci-project

Figure 1: Screenshot of Reel the Real

often require sophisticated hardware and software like Oculus Quest, PC-VR which might be a hurdle for wider adoption. One notable application among them is Mozilla Hubs [1] that uses a room like environment but it has one drawback - the room has a single voice channel and it impedes the smaller group discussions within the room.

VRCollide [9] did a user study for comparison of visual feedback mechanisms of Avatar, BoundingBox and CameraOverlay, for preventing collisions between co located users. Number of collisions turned put to be fewest in BoundingBox, but users preferred Avatar and CameraOverlay interactions. The results also says that Avatar has the fastest movement time, while BoundingBox was the slowest. ICOCOON [3] aims to provide the same feeling of conventional in-person face-to-face meeting by virtually simulating the participants to be in the same location. Their Virtual Meeting Room (VMR) application detects events like a participant entering the meeting room, talking, presenting, etc using computer vision and use the 3D humanoid avatars to convey these actions. While this is a good feature to track the user movements by cameras, it often creates unnecessary overhead in the events like virtual conferences, hence not suitable for this problem. Instead we propose to use the concept of avatars which can be navigated and interacted through standard keyboard, mouse and other input device movements.

FORMATIVE STUDY

Goal & Study Design

Before starting to build out the application, we did a formative study through a semi-structured interview to better understand the needs and preferences of the target group. We recruited two participants, a Masters Student who frequently attends career fairs and a PhD student who attends research conferences. During the interview, two members from our group took notes and recorded audio with the consent of the participants, one member asked the questions, and one member moderated the discussions. We formulated questions that are key to designing and building the application. Initial questions were related to the overall idea and its usefulness to the end user. Then we asked questions about the limitations of the current tools as well as requested a comment on our initial design. Finally we asked about the preferred features that the participants think are important in providing an in-person feel.

Findings

This formative study helped us to analyse specific problems, and improve our web interface design. Moreover, we were able to identify which features were most important to the users for their needs, gather their perspectives about our idea and know the problems they faced while attending large virtual gatherings using platforms like Zoom, Handshake etc.

The following are the major insights we gathered:

- Both interviewees stated that avatar movement and file sharing are important/must have features.

- New feature suggestion from interviewees: Keeping track of history (list of tables visited or people interacted with).

- Web application would be much better than standalone application. Mostly because it is more convenient.

- Avatar should have a username and one-liner description/label which can be helpful to get basic background information.
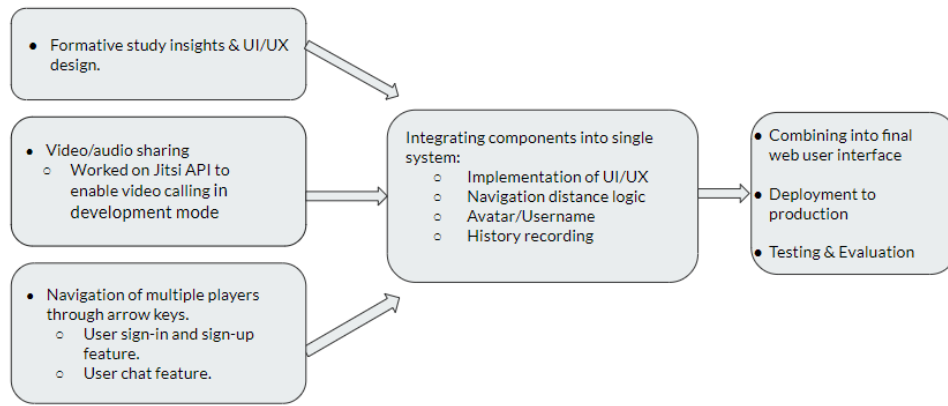
Figure 2: Project Workflow

- Conference tables should have some description about the agenda of the ongoing discussion.

Final Features

Below are the final features that we prioritized in our application, based on the insights from the formative study.

- Navigate in all 4 directions to interact with others inside virtual room environment
- Flexibility to chat and share files within a group of people in vicinity
- Video and audio enabled automatically when in vicinity of another person
- Individuals should be able to freely move, join and spectate conversations
- Track History of User Movement and table description
- Each person will have their own virtual avatars

METHOD & IMPLEMENTATION

Implementation Details

In the figure 1, we have shown our project workflow. On the left hand side, we have three separate components - Formative study insights & UI/UX design, Video/audio sharing feature and multi player platform to navigate on map through arrow keys. For video/audio sharing feature, we have used WebRTC [2] which is a free, open-source project that provides web browsers and mobile applications with real-time communication. In particular, we have used PeerJS[3] which simplifies WebRTC peer-to-peer data, video, and audio calls. For vicinity, euclidean distance between the peers is used. For saving user credentials MongoDb server is utilized. For chat messaging, all the messages go through the server. In this way, if a user tries to send in some offensive text then the host can control the communication. We have also used SSL which allows web browsers and web servers to communicate over a secure connection. Finally, we have hosted our server on a AWS EC2 instance.

2 https://webrtc.org/
3 https://peerjs.com/

Technology Stack

Based on initial user study feedback we decided to build 'Reel the Real' as a full stack web project instead of a desktop or mobile application. For the frontend part of our project - we used HTML,CSS and plain Javascript. We avoided the use heavy client side Javascript libraries for optimal performance. For making the backend we used NodeJS keeping in mind the ease with which it integrates with WebRTC. We used MongoDB as our database and deployed Amazon Web Services' Elastic Compute Cloud instances (AWS EC2) to host the project.

Functionalities Provided

Reel the Real provides the following functionalities:

- Virtual avatar which the user can use to navigate across the arena using arrow keys.
- MongoDB used to persist user credentials
- Centrally controlled chat box managed by the server which can be used to monitor chats and block offensive content.
- Interaction history of each user is stored in the server, which can be shared with the user by email after the meeting/fair ends.
- Use of SSL/TLS for securing the application.

USER STUDY

To evaluate the application we built and to further gain insights to understand the usability of our proposed solution to solve the research question stated, we did a user study. The user study method chosen is "Virtual Synchronous Career Fair" i.e., to simulate a virtual career fair, which is one of the large virtual gathering settings that our application is well-suited. We recruited 6 participants, 2 Female and 4 Male. Out of the 6 participants, 4 are Computer Science graduate students, 1 Computer Engineering graduate student, and 1 Data Science working professional. Every participant attended both in-person and virtual career fairs before.

Virtual Synchronous Career Fair

Since the focus is to compare the usability against platforms like Zoom, we asked the users to participate in a simulated career fair in Zoom breakout rooms, followed by "Reel
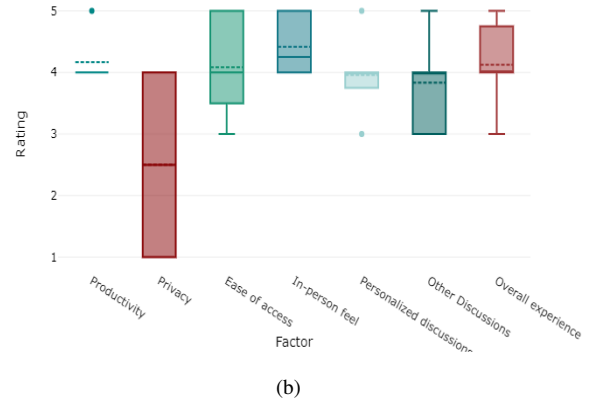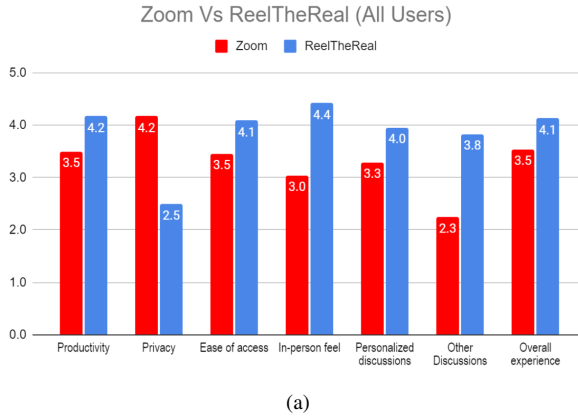
Figure 3: Evaluation Results. (a) Barplot of ratings for Zoom and Reel the Real, (b) Box plot of ratings for Reel the Real.

the Real". It is a Within-subjects study design so all the users tried both the systems. As a part of the bias removal / minimization efforts, we let the users do a test run in Zoom first so that they are well familiar with the concept of the user study, and second we randomly assigned the roles to the participants for each setting.

We randomly assigned the 6 participants to two roles: 4 jobseekers and 2 recruiters. Recruiter A is hiring a Data scientist, Recruiter B is hiring an Software Development Engineer (SDE) while Students A, B are seeking a Data Science job and Students C, D are seeking an SDE job. The idea is to get a sense of the experiences which are often different for recruiters and jobseekers. The participants were unaware of each others' roles before the interaction. The Job requirements, Candidate skills and some Sample questions were given by us to facilitate easy conversations. There were 2 breakout rooms in Zoom and 2 tables in Reel the Real - each with a recruiter. We asked the participants to follow First Come First Serve (FCFS) method in our system, while others stand in queue (similar to in-person setting). Participants added their name and role in username when the user study started. In Zoom, we manually assigned 1-on-1 sessions in breakout rooms, a setting in which the career fairs are taking place currently during the COVID-19 pandemic.

Evaluation Questions

After the user study is done, we asked the participants to rate both the platforms on a scale of 1 - 5 (1 being the lowest and 5 being the highest) in terms of:

- Productivity & Information exchange
- Privacy
- Ease of access
- In-person feel
- Personalized discussions
- Switching to other discussions
- Overall experience

Apart from that we also asked questions to get descriptive responses. It was semi-structured style, with the initial questions being as follows: What problems did you face while using each platform ? and What did you like the most in our platform ?

Evaluation Results

Figure.3a and Figure.4 shows the ratings given by the participants for different factors. It is observed that recruiters had either the same or a better experience than students for all of the factors. For the overall ratings, Reel the Real had better ratings than Zoom breakout rooms except for Privacy. This is an expected result since the setting in zoom is 1-to-1 which allows greater privacy, while Reel the Real, similar to in-person gatherings, has comparatively less scope for privacy. The boxplot in Figure.3b shows that there is a notable variance in the ratings for Reel the Real, especially in factors like privacy, ease of access, other discussions and overall experience. This means, not all the participants felt the same way and their experience regarding these factors stood different.

To assess the statistical significance of the increase in overall ratings from Zoom to Reel the Real, we performed one tailed paired t-test. It turned out that although, the ratings were higher for ease of access, personalized discussions and overall experience, they are not statistically significant. But productivity, in-person feel and other discussions remained statistically better than that of Zoom. The lack of significance for ease of access and overall experience is sort of unexpected due to the fact that the application is browser based and easy to use.

The semi structured style questions asked after the study, had given us clear insights and an explanation on why there were different experiences among different participants, and why ease of access, overall experience did not remain statistically significant. The notable comments from these questions are as follows: Participants said our platform is interesting and fun. Everyone felt it was quite easy to use as no installation is required. But one participant faced issues in Firefox while Chrome & Safari worked smoothly. We also observed that this participant gave less rating for the application for the ease

Factor	Recruiter Ratings		Student Ratings		Overall Ratings		One tailed paired t-test	
	Zoom Breakout Room	ReelTheReal	Zoom Breakout Room	ReelTheReal	Zoom Breakout Room	ReelTheReal	p value	Significant at p<=0.05
Productivity	3.0	4.5	3.8	4.0	3.5	4.2	0.050	Yes
Privacy	4.5	2.5	4.0	2.5	4.2	2.5	-	-
Ease of access	3.4	4.3	3.5	4.0	3.5	4.1	0.202	No
In-person feel	2.1	4.8	3.5	4.3	3.0	4.4	0.037	Yes
Personalized discussions	2.9	4.4	3.5	3.8	3.3	4.0	0.142	No
Other Discussions	1.8	4.5	2.5	3.5	2.3	3.8	0.011	Yes
Overall experience	3.6	4.9	3.5	3.8	3.5	4.1	0.110	No

Figure 4: Evaluation Ratings

of access factor. One participant liked the simplicity of the design and said they prefer this prototype over a full feature application. Other suggestion given by a participant is that we can use this application in classes instead of zoom since they felt it is more interactive than 1 to 1 zoom video. Participants felt the application started lagging when more than 10 users are connected concurrently. This along with the browser issues faced by one user, explains the above stated anomaly of no significance in ease of access.

Two participants said they are very concerned with privacy and personalized discussions; and that they would always prefer a virtual 1-on-1 meeting than in-person or Reel the Real. It is also observed that the ratings from these two participants were critical compared to others, and explains the reason for overall experience could not turn out to be statistically better than Zoom. Another fun incident took place during the user study where two participants started casual chit-chatting at an empty table after they were done with interactions, without actually disturbing the other ongoing interactions. This reflects one of our goals to allow the users be able to initiate small group discussions on-the-go, similar to an in-person gathering.

DISCUSSION & CONCLUSION

We faced some challenges over the course of our work and some other challenges in general which had a greater impact on the results. Scheduling a synchronous user study with the availability of all participants was challenging. Zoom round moderator had a very tough time managing the sessions, which shows the drawback in such a system, while Reel the Real did not required any moderator. The preference of zoom 1-on-1 vs in-person depends on personal taste and it indeed affected the ratings from the participants. While we expected ease of access to be better in our platform, but it wasn't due to the lag caused by WebRTC, PeerJS & the browser issues.

There are some limitations in our application and the work as follows: Reel the Real does not offer much privacy or personalized discussions as compared to Zoom 1-to-1, although this is by design since we wanted to give a better in-person experience than privacy. This is the reason why we suppose

the recruiters' ratings were better than students, since privacy is not as applicable to them, as it is for students. The user study conducted had a small sample size of only 6 participants, and having more participants might give more insights and help to better eliminate the bias. Our application currently lags when the number of concurrent participants is significantly more. This is a prototype application with a limited set of features, and the availability of other features might improve or even hinder the performance, thereby the results as well.

The major strengths of our application are - it works in browser with no installation required. It indeed gives an in-person feel of virtual gatherings (queue, navigation etc) and it makes it easy to switch between the discussions. Reel the Real is more interactive than existing applications and is fun to use. Users can initiate a discussion with anyone on-the-go, similar to in-person gatherings. Those who prefer in-person gatherings, will most probably like our platform as compared to zoom and other virtual meeting platforms. Reel the Real is perfectly suitable for many-to-many gatherings with no privacy concerns.

REFERENCES
[1] 2019. Hubs by Mozilla. https://hubs.mozilla.com/. (2019).

[2] Angela Bonifati, Giovanni Guerrini, Carsten Lutz, Wim Martens, Lara Mazilu, Norman Paton, Marcos Antonio Vaz Salles, Marc H Scholl, and Yongluan Zhou. 2020. Holding a Conference Online and Live due to COVID-19. *arXiv preprint arXiv:2004.07668* (2020).

[3] Aljosha Demeulemeester, Katriina Kilpi, Shirley A. Elprama, Sammy Lievens, Charles-Frederik Hollemeersch, An Jacobs, Peter Lambert, and Rik Van de Walle. 2012. The ICOCOON Virtual Meeting Room: A Virtual Environment as a Support Tool for Multipoint Teleconference Systems. In *Entertainment Computing - ICEC 2012*, Marc Herrlich, Rainer Malaka, and Maic Masuch (Eds.). Springer Berlin Heidelberg, Berlin, Heidelberg, 158–171.

[4] Niclas Johansson. 2019. The 10 best VR meeting apps – productive remote collaboration. https://immersive.ly/best-vr-apps-productive-remote-meetings/. (2019).

[5] Brennan Jones, Yaying Zhang, Priscilla Wong, and Sean Rintel. 2020. VROOM: Virtual Robot Overlay for Online Meetings. In *CHI2020 Late Breaking Work*. ACM SIGCHI. `https://www.microsoft.com/en-us/research/publication/vroom-virtual-robot-overlay-for-online-meetings/`

[6] Fernando Kleiman, Sebastiaan Meijer, and Marijn Janssen. 2020a. Gaming for Meaningful Interactions in Teleworking Lessons Learned during the COVID-19 Pandemic from Integrating Gaming in Virtual Meetings. *Digital Government: Research and Practice* 1, 4 (2020), 1–5.

[7] Fernando Kleiman, Sebastiaan Meijer, and Marijn Janssen. 2020b. Gaming for Meaningful Interactions in Teleworking Lessons Learned during the COVID-19 Pandemic from Integrating Gaming in Virtual Meetings. *Digit. Gov.: Res. Pract.* 1, 4, Article 31 (Sept. 2020), 5 pages. DOI:`http://dx.doi.org/10.1145/3416308`

[8] Joshua S Rubinstein, David E Meyer, and Jeffrey E Evans. 2001. Executive control of cognitive processes in task switching. *Journal of experimental psychology: human perception and performance* 27, 4 (2001), 763.

[9] Anthony Scavarelli and Robert J. Teather. 2017. VR Collide! Comparing Collision-Avoidance Methods Between Co-Located Virtual Reality Users. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '17)*. Association for Computing Machinery, New York, NY, USA, 2915–2921. DOI:`http://dx.doi.org/10.1145/3027063.3053180`

[10] Constance Steinkuehler. 2007. Massively multiplayer online games & education: an outline of research. 675–685.