


# How Ethnographic Practices Are Reconfigured with 360-degree Cameras

Naoya Tojo<sup>1</sup><sup>a</sup>, Tomoko Oto<sup>2</sup> and Sumaru Niida<sup>1</sup><sup>b</sup>

<sup>1</sup>*KDDI Research, 2-1-15 Ohara, Fujimino, Saitama, Japan*

<sup>2</sup>*JAIST, 1-1 Asahidai, Nomi, Ishikawa, Japan*

**Keywords:** Ethnography, Qualitative Research, Observational Research, 360-degree Camera, Technology Intervention.

**Abstract:** Ethnography has become common in human-computer interaction research as both a methodology and a research subject. Ethnographic practices have historically been enhanced with the introduction of new technologies. Responding to the emergence of 360-degree panoramic technology that enables comprehensive visual recording and an immersive viewing experience, we specifically explore how 360-degree cameras bring new value to ethnography. To examine this concept, we conducted a focus group discussion with seven ethnographers and an interview study in which an additional five ethnographers were asked about experiences in the use of 360-degree cameras. From the results, we constructed distinct aspects to start a discussion on the future research and practice of ethnography using 360-degree cameras. We also report the early challenges that ethnographers encountered and discuss supporting technologies to overcome the challenges. Reflecting on the findings, this paper contributes to the design implications of ethnography with 360-degree cameras.


## 1 INTRODUCTION


Ethnography is the most representative genre of qualitative research (Marshall and Rossman, 2001) and a fundamental feature of design that is researched in human-computer interaction (HCI) communities. In ethnography, researchers coordinate and integrate multiple methods and tools to collect data and describe subjects (Coffey et al., 2006). Recent development in multimedia technology has accelerated the collection, utilization, and presentation of various forms of data (Emmison et al., 2012) and has enabled digitally enhanced and advanced ethnography (Pink et al., 2015). In particular, digital cameras are the major recording medium along with fieldnotes and have made visual recording and presentation of events, subjects, and interactions during research much easier (Marshall and Rossman, 2001). After the 2010s, 360-degree cameras that enable omnidirectional recording and presentation were introduced, and in the late 2010s, practices using them in ethnographic context were seen in the research community (Mendonca and Ray, 2017; Cruz, 2017).

Notably, 360-degree cameras provide comprehensive visual recording and immersive viewing experiences that are limited when using traditional cameras.

Our research examines how the methodologies and practices of ethnography can be developed by 360-degree panoramic technology; however, intervention in research processes by new tools and methods influences the relationships between researchers and research subjects (Alvero and Austin, 2004; Faklaris et al., 2020) and raises new challenges for ethnography (Crabtree et al., 2006). Therefore, to enhance the reliability of ethnography with new tools or methods, their influences need to be identified throughout the process and scrutinized. Discussing the impact of the use of 360-degree cameras on ecosystems of ethnography and their academic implications is just as important as testing 360-degree cameras in practice. However, although practices of the use of 360-degree cameras in ethnography are emerging (Mendonca and Ray, 2017; Cruz, 2017), there is a lack of coherent understandings regarding the basis of discussion for researchers and practitioners to incorporate 360-degree cameras into this field.

To explore this topic, we examined the potential values of ethnography with 360-degree cameras with researchers and practitioners. We report on a series of studies based on a design approach for speculating about future experiences of emerging technologies (Dunne and Raby, 2013). We first conducted a focus group discussion (FGD) with seven ethnographers to speculatively explore opportunities and challenges of

<sup>a</sup> <https://orcid.org/0000-0002-5454-384X>

<sup>b</sup> <https://orcid.org/0000-0003-2208-8819>

ethnography with 360-degree cameras. Then, we conducted the interview study in which we interviewed five participants including pioneering users of 360-degree cameras in their ethnographic practices, and we deepened aspects formed from the FGD.

Our analysis presents how the overall activity of ethnography will be reconfigured by the introduction of 360-degree cameras. In particular, the main contribution of our findings is a framework comprising distinct aspects which may be employed to start a discussion on ethnography using 360-degree cameras. We additionally present the initial challenges encountered during the early stages of the application of these cameras in ethnographic practices. These challenges simultaneously imply the need for future technologies to support ethnography with 360-degree cameras. Note that we emphasize that the focus of this paper is not necessarily to suggest that ethnographers should make full use of 360-degree cameras and related technologies in the future, but rather enable in-depth consideration of ethnography and its methodology.

## 2 RELATED WORK

In this section, we first summarize the cycle of ethnographic research practices and technology interventions for it. Then, we review the literature on digital tools and methods in ethnography.

The ethnographic research process can be outlined by cyclical pattern that consists of generating ethnographic research questions, collecting ethnographic data, creating ethnographic records, analyzing ethnographic data, and producing ethnographic deliverables (Spradley, 2016). Ethnographers use mixed methods, multimodal approaches, and various tools to collect data. The most basic means are taking fieldnotes, acquiring photographs and videos, audio recordings, and collecting primary source references (Marshall and Rossman, 2001). Ethnographers convert those data into findings by editing, coding, or clustering them (Patton, 2002). Our study in this paper discussed not only specific aspects of ethnography but also the influences of introducing 360-degree cameras on practices in the entire cycle of ethnographic research.

Digitization is one of the major trends of ethnography in recent years and is an important contact between ethnography and HCI research. Ethnographic research has historically been enhanced with the introduction of new technologies (Anderson et al., 2009). For example, online tools such as web questionnaires and email interviews have reduced time and monetary costs for researchers (Murthy, 2008).

Online sites such as social networks and chatrooms have brought about new exploration spaces (Chapman and Lahav, 2008; Postill and Pink, 2012). Previous studies reported ethnographic data collection approaches using Google Street View (Kostakos et al., 2019), YouTube (Paay et al., 2015), or wearable devices (Thoring et al., 2015). Because fieldwork provides a vast number of qualitative (and sometimes quantitative) data, ethnographers increasingly use computer-assisted qualitative data analysis software (Coffey et al., 2006). The traditional manner of ethnographic representation has long been paper-based form, whereas recent hypertext and multimedia technologies have enabled qualitative and ethnographic representation on the web and through computer applications (Lemke, 2002).

Photographs and videos have a particularly long history in ethnographic fieldwork (Coffey et al., 2006). Digital cameras are the most accepted tools and have enabled us to visually record sharp images and videos of ethnographic sites (Murthy, 2008). Photographs and videos have been used in a variety of scenes such as documentation, representation, and reflection (White, 2009; Buur et al., 2010).

In comparison with traditional cameras, 360-degree cameras provide more comprehensive visual records and 360-degree contents provide immersive experiences for viewers. We consider that the introduction of such cameras and contents into ethnography enables more advanced recording and representation of physical space information. However, while 360-degree cameras and contents are well recognized in the context of consumer applications (Jokela et al., 2019), to our knowledge, the basis for ethnography with 360-degree cameras has not yet been discussed. Accordingly, intermediate-level knowledge is required to bridge the gap between research and practices.

To summarize this section, ethnography is common in both HCI practice and research. Its cycle consists of various steps. In ethnography, digital technologies are now valuable tools and resources enabling researchers to deeply understand their subjects. Some practical reports suggest the potential for 360-degree cameras to advance ethnography (Mendonca and Ray, 2017; Cruz, 2017); however, there is no common basis for discussion on the use of 360-degree cameras in ethnography. We aim to extend the scope of previous works and provide the basis for discussion on new practices.

### 3 RESEARCH APPROACH

To discuss the potential of a previously unexamined topic in ethnography, namely, 360-degree cameras, we used a speculative approach in HCI (Dunne and Raby, 2013) and our designed research approach. The most difficult task in our study was the recruitment of participants with experience in ethnography using 360-degree cameras.

To address this difficulty, we first designed a formative and speculative FGD with ethnographers who had no experiences in the use of 360-degree cameras. It was relatively easy to recruit such participants. We gave them the opportunity to use these cameras, taking photographs and videos, and to watch 360-degree content to help them obtain a more concrete understanding of the application of this technology in the future. From the FGD results, we framed aspects of ethnography with 360-degree cameras. Reflecting on the aspects, we designed an interview study with ethnographers who “had experience” in the use of 360-degree cameras. Since the number of such pioneering participants was limited, we conducted in-depth interviews to obtain deeper insights.

#### 3.1 Focus Group Discussion

This subsection outlines the FGD wherein we speculated with ethnographers regarding future experience with 360-degree cameras in an ethnographic context.

**Participants.** We recruited seven ethnographers through social networking services from an ethnographer’s community. They participated in the FGD without a reward. Three participants were practitioners in companies who incorporate ethnographic approaches into their work. The other four participants were researchers who conduct research related to ethnography at universities. The participants had an average of 9.7 years (2-16 years) of ethnographic experience. In addition to the seven participants, two researchers participated in the workshop as facilitators.

**Facilitation.** First, we explained the context and aim of our study and introduced trends of technologies and devices related to 360-degree cameras to the participants. Then, two facilitators facilitated two types of work in parallel, respectively. One was the FGD for which we prepared three different types of 360-degree cameras (RICOH Theta V, Samsung Gear 360, and kodak PIXPRO SP360). Participants discussed the use of 360-degree cameras in ethnography while handling cameras and trying to take photographs and videos. The other was hands-on activity in which participants watched 360-degree videos we recorded

in past fieldwork on a headmounted display (HMD, Samsung Gear VR with Galaxy S8), a PC monitor, and a smartphone screen, respectively. Participants basically participated in the FGD, during which each participant participated in the hands-on activity work in turn. The FGD and the hands-on activity lasted 50 minutes. In this way, participants speculated about future applications through the experiences of watching, acquiring, and being captured with 360-degree panoramic technologies. The dialogue during the FGD was recorded by a voice recorder. Finally, the facilitators summarized the discussion.

**Analysis.** We transcribed the audio data of the FGD in full. We constructed a conceptual framework from the transcript using thematic analysis to extract aspects of ethnography related to the use of 360-degree cameras. A conceptual framework is a coding technique used to understand user expectations and experiences regarding a particular application or technology (Aladwan et al., 2019). The first author undertook coding as a coder. First, the transcript was divided into 1822 blocks depending on the speaker and the content of the dialogue. Then, after iterative open coding, axial coding was conducted to consolidate codes under coherent groups. These codes formed categories and core concepts. Finally, three researchers including the coder reviewed and refined them.

#### 3.2 An Interview Study

This subsection outlines the interview study that reflected the aspects extracted from the FGD and was conducted to capture early practice regarding the use of 360-degree cameras in ethnography.

**Participants.** Recruitment of appropriate participants was a major difficulty in our research process because the use of 360-degree cameras in ethnography is still in the pioneering phase. We recruited five participants via snowball sampling (Goodman, 1961) from the surrounding ethnographer community without offering a reward. The small sample size reflects the emergent state of our topic. The participants had an average of 16.3 years of ethnographic experience. Three participants in the industrial sector were staff members of a system integrator (P1), a consulting firm (P2), and an electronics company (P4) and have been involved in ethnography for the purposes of understanding customers and market research. The approximate size (the number of employees) of the organizations varied from less than 50 (P2) to 1,500 (P1) and 100,000 (P4). The other two participants in the academic sector were a cultural anthropologist (P3) and a political economist (P5) who have been involved in

ethnography for academic research and educational purposes. P1, P2, and P3 had used 360-degree cameras in ethnography, and P4 had used one in another context. P5 had purchased a 360-degree camera for use in ethnography but had not used it.

**Design and Analysis.** Each interview lasted approximately two hours and was conducted via a video conferencing system (Zoom). Two researchers (interviewers) and a participant entered the Zoom meeting and conducted the interview with the video activated. The interviews were semi-structured and focused on what tools are used in ethnographic practices, how 360-degree cameras are understood and differentiated from other tools, how 360-degree content is handled, and what challenges the participants faced. We recorded video and dialogue during the interviews. We transcribed the audio data of the interviews in full and iteratively categorized them together into major themes using an inductive approach (Corbin and Strauss, 2008).

## 4 RESULTS

Our findings are twofold: a conceptual framework and early applications in ethnography using 360-degree cameras. This section describes the conceptual framework and several aspects of the discussion on ethnography using 360-degree cameras.

As a result of the coding from the FGD, four distinct but closely interrelated categories comprising function, action, analysis, and delivery emerged. Several design considerations regarding the introduction of 360-degree cameras into ethnography were identified as components of the categories. Consolidating all of these, we propose the conceptual framework shown in Table 1 to facilitate effective discussion on the use of these cameras in ethnography in the future. The following subsections describe each category and the related components.

### 4.1 Function

The category of function includes components that could influence the design of ethnography. There were comments on the recording time of videos, with participants reporting that, ideally, approximately 2-4 hours of recording time were required for fieldwork. However, currently, typical 360-degree cameras can record continuously for only several minutes up to tens of minutes due to constraints of the heat generation and memory capacity. Hemispherical cameras are more suitable for recording for longer time periods than omnidirectional cameras. Moreover, as

an alternative, we can choose the option of designing surveys in slots of a few minutes. To ensure recording, redundancy of data and batteries is required. One participant commented “I formerly used one voice recorder and failed to record. I use two now. I don’t fully believe in machines ...” It is necessary to consider and prepare for a weak battery and insufficient memory.

There were comments about the resolution of 360-degree content, for example, “need a higher image quality.” Although most currently available 360-degree cameras already support 4K resolution, the actual quality of the field of view is not 4K because the user views a part of the image projected onto a spherical surface through a monitor or an HMD (Hebbel-Seeger, 2017). On the other hand, there was a comment indicating acceptance of low image quality: “I am wondering what the priority is, and I don’t think I care about the number of pixels.” Therefore, we can choose the option of capturing the overall dynamics of the field with a 360-degree camera, and if necessary, capture photographs or videos of the part that a researcher wants to record in higher quality with a conventional digital camera.

Regarding the operability of the cameras, it was found that the user interface (UI) between the camera and its related devices was complex. There were many comments about the difficulty of pairing between the cameras and smartphones and about the procedures for operating the devices and software applications. It is necessary to ensure that operational aspects do not interfere with conducting a smooth survey. Additionally, a more user-friendly UI is desired.

In terms of viewpoint, when users watched 360-degree content, there were comments of “there’s a feeling of floating” and “there is only one viewpoint even if I can see in 360 degrees, there is a limitation.” Therefore, when using 360-degree cameras, the location and number of cameras may also need to be incorporated into the design. It is necessary to consider how the viewpoint decided by the location of a camera affects the viewer’s observation and interpretation.

In the FGD, some of the participants experienced VR sickness after watching for only a few seconds. The VR sickness was particularly severe when the participants were watching handheld videos. For this reason, 360-degree videos have to be taken in a fixed position or with a handheld stabilizer. As countermeasures, image stabilization technologies and watching methods to reduce VR sickness are in the research phase (e.g. (Kasahara et al., 2014)).

Table 1: Themes and components to facilitate discussion on the applications of 360-degree cameras to ethnography.

Function	Action	Analysis	Delivery
Recording time	Planning	Collaboration	Editing
Redundancy	Shooting	Searchability	Digital archiving
Resolution	Attitude	Reinterpretation	Open source
Operability	Modality	Overviewing	Presentation
Viewpoint	Comprehensiveness	Listening	
VR sickness	Consciousness		

## 4.2 Action

Components related to the planning of fieldwork were provided. For example, researchers can reduce uncertainty in a survey by forming an impression of the field with 360-degree content (e.g., Google Street View) in advance.

Regarding the action of shooting photographs and videos, it was mentioned that, unlike conventional cameras, it is not necessary to consider the composition of a picture. That is, 360-degree cameras enable us to create holistic visual records, which may open up new opportunities for observation. There were also suggestions for qualitative biologging by attaching cameras to dogs and cats and recording video from a child's viewpoint.

Ethnographers mainly use fieldnotes, voice recorders, and cameras to record events during their observation; however, the introduction of 360-degree cameras may reconfigure attitudes about what researchers should record in each medium. For example, "there is a limit to what a researcher can do in fieldwork, so I want to allocate visual perception to this [360-degree camera], and if possible, I'll concentrate on what I feel." Accordingly, consciousness of data collection may change. A researcher can take the approach of recording more subjective information such as one's emotions and sensations of temperature, smell, and wind in fieldnotes while recording objective information through the audiovisual functions inherent in 360-degree cameras. Moreover, one participant's comment of "I don't feel like I'm being filmed much" implied that a subject's awareness of being observed decreases in the case of 360-degree cameras more than with conventional cameras. In general, viewing subjects through the lens of a camera causes discomfort to some subjects (Larcher and Oxley, 2015). The influence of 360-degree cameras on subjects' feelings of being filmed requires comparison with other types of cameras.

Capturing a field with all five senses is a requirement in ethnographic observation. On the other hand, 360-degree cameras record audiovisual information. This fact led to the participants' concerns about the modality of the events being recorded. For example,

one participant said "feeling coolness in the morning, feeling relieved in the daytime, people are working, and then saying 'I'm tired' in such an environment, and saying 'I'm tired' in an air-conditioned room like this one [a meeting room], these are different."

Comprehensiveness of visual information was mentioned. During fieldwork, researchers can obtain visual information only from the direction in which they are looking; however, by using 360-degree cameras, they can record videos of a field including the "condition of the surroundings" with fewer blind angles and can review them later. This feature allows the researcher to concentrate on recording nonvisual information in the field. On the other hand, this feature may also arise ethical concerns and we mention in the following section.

## 4.3 Analysis

The possibility of collaboration in analysis was mentioned. In classical ethnography, a single researcher tends to undertake field research and engage in analysis and description that is dependent upon his or her individual expertise. In contrast, the FGD participants expected that the use of 360-degree videos particularly enhances team ethnography involving multiple members: "I think it's possible to perform ethnography with a team. Especially in business ethnography, several members participate in analysis."

There were concerns about the low searchability of scenes in 360-degree videos. It is necessary to move the scene in the 360-degree video not only temporally but also spatially in order to watch a specific scene. A panoramic viewing may be better in this case. Moreover, a researcher should record the times when characteristic events occurred during fieldwork to facilitate access to specific scenes during analysis; otherwise, technological intervention would be required.

It was mentioned that the interpretation of events may differ between direct observations by a researcher in the actual field and observations made through 360-degree content, leading to a concern being raised about reinterpretation. However, changes in interpretation due to iterative references to data

often occur in traditional observational studies, as a participant indicated by stating that “isn’t it exactly the same as when we look back at the fieldnotes we took in the field, interpretation changes?” Whether the reinterpretation that occurs with fieldnotes, photographs, videos, and the other media in a conventional study is the same as the reinterpretation that occurs with 360-degree content and how they differ are matters open to discussion.

In the FGD, 360-degree videos were also presented in a panoramic format. Related to this viewing method, there were comments concerning the discomfort of not being able to intuitively understand the positional relationships among people and objects. On the other hand, there were positive comments that the viewing method allows over-viewing an environment from a bird’s-eye view. An effective selection strategy of a method of viewing is required to be discussed. Concerns were raised about spatial audio listening. Although the viewpoint of a researcher who watches a 360-degree video is tied to a specific direction within a 360-degree image, it is difficult to relate the direction of the audio source to the 360-degree video. To achieve a spatial audio recording and experience, it is necessary to use a combination of other audio recording methods.

#### 4.4 Delivery

Before using ethnographic videos for academic presentations or reports to stakeholders, a researcher edits the videos. If 360-degree cameras are introduced and become commonly used in ethnography and 360-degree content comes into greater use, how the footage will be edited and the interfaces employed for editing the 360-degree content are subjects open to discussion. Regarding the presentation of 360-degree content, there were comments that it is difficult to instruct viewers regarding where to look and that viewers may be afraid of standing up when wearing an HMD. In addition, a concern was raised about how to integrate 360-degree content into printed media including books and papers.

There were comments about the advantage of digital archiving. Archives of 360-degree content allow researchers to later confirm viewpoints that they did not pay attention to during a survey. Archives may also allow comparison of the same research field over long periods of time. Making those archives open sources enables comparison of research fields not only by the researchers and team members directly involved in the study but also by other researchers, which may lead to more multifaceted interpretations.

## 5 PRIMARY CHALLENGES

Reflecting on the experiences of pioneering users who used 360-degree cameras in ethnography, we summarize the five main sets of challenges that they faced in the applications of these cameras. Each challenge is related to not only a single but several categories and components of the conceptual framework that we constructed. The following analysis is not an attempt to summarize all of the issues involving the use of 360-degree cameras in ethnography. Rather, we aim to use these as a starting point for a discussion on the design implications.

### 5.1 Ethical Considerations

Regardless of the use of 360-degree cameras, the use of cameras and media in ethnography is always accompanied by ethical issues including consent, anonymization, presentation, and access to data (Coffey et al., 2006; Lee et al., 2019). Because scenes that are not originally intended to be recorded are also recorded inadvertently due to the “comprehensiveness” of recording when 360-degree cameras are used, nontraditional ethical issues will arise. This concern must be considered more carefully when creating digital archives of ethnographic data and making open sources from them. In our study, all participants agreed that ethical considerations must be discussed. In particular, our participants had high expectations for automatic anonymization processing technology for 360-degree content. Previous research on guidelines for the use of cameras in qualitative research and privacy protection technology in videos (Lee et al., 2019) may be helpful to discuss the use of 360-degree cameras in the same way. Moreover, there is a need to examine observer effects and the differences in a subject’s reactions and feelings in the cases in which 360-degree cameras are used since a previous study has indicated that a subject’s reactions and feelings differ depending on the particular recording devices used (Singhal et al., 2016).

### 5.2 Positioning on Ethnography: A Tool or Genre?

The challenging question of how 360-degree cameras can be integrated into existing ethnography was raised. In terms of the desirability of using 360-degree cameras as a new genre derived from classical ethnography such as digital ethnography and business ethnography, P3 and P5 agreed that it has significance. There is room for exploration in a new ethnography oriented to the 360-degree recording. P5 said

“comprehensively understand ... isn’t that great anthropology? From that point of view, I’m thinking it’s great I can take 360-degree images.”

On the other hand, in terms of use as a tool, none of the participants used 360-degree cameras effectively in the academic context. The fundamental reason is that no one has yet explained what 360-degree cameras and content are in the ethnographic context. For discussions from the perspective of academic (and particularly classical) ethnography, it is important to define 360-degree cameras in the context of ethnography, as P5 said “without a clear definition of the concept of ethnography [with 360-degree cameras], we cannot move.” To introduce 360-degree cameras into more classical ethnography, the semiotic and interpretive implications of the corresponding content need to be clearly defined.

### 5.3 Cost-effectiveness

Evaluation and decision-making regarding cost-effectiveness are important in design processes (Boletsis, 2018), particularly in a business context. P1 and P2 said that it is difficult to introduce 360-degree cameras into ethnographic projects because their effectiveness had not been demonstrated. P5 also mentioned that some were hesitant to introduce this technology due to the lack of precedent: “if there is good precedent, we’re going to actually try to use it.”

It was found that it was difficult for ethnographers in companies to allocate resources for reviewing and analyzing 360-degree content because they had carried out their work by balancing the various tasks including not only fieldwork and interviews but also analysis and reporting to the client. P2 mentioned that searchability of scenes also decreases the cost-effectiveness of ethnography with 360-degree cameras.

Since ethnographers have yet to find an effective method for analyzing the massive quantity of qualitative data generated by 360-degree cameras, technological interventions for data analysis are expected. For example, the participants mentioned a method of compressing the duration of the video and a method for creating highlights from the original video. These methods will reduce both the burden on the researcher and the time costs. Most participants felt that there was a strong need for a method that automatically processes, encodes, and summarizes 360-degree data. Such a method will allow a researcher only to interpret the extracted findings. This concept is related to machine learning and ethno-mining (Murray-Rust et al., 2019) which involves ethnographic big data analysis. These technologies can contribute not only

to cost-effectiveness but also to deepening our understanding of the subjects and may provide insights that produce more developed HCI designs.

### 5.4 Security Risk

The strict rules governing security risk management such as the loss, leakage, or tampering of customer or confidential information, have presented barriers to the introduction of 360-degree cameras and related software in companies. P1, who was an ethnographer in a large company, said, “it’s hard to introduce it because of the problems of information leaks and security.” Security issues also arise for ethnographers in academia who participate in the industrial field. For example, P5 mentioned that it may be difficult or impossible to use cameras for participatory observation in company offices or in factories due to confidentiality concerns. Moreover, 360-degree cameras can inadvertently record people and objects targeted by a researcher. These features become a barriers to the use of 360-degree cameras in fields where there are concerns about privacy or security issues. To overcome this issue, technologies are required to automatically protect personal and confidential information. Assuming the use of this protective technology, informants’ psychological barriers to the use of 360-degree cameras in a survey can be overcome. Moreover, security guidelines for the introduction and use of 360-degree cameras need to be discussed. These considerations will facilitate the introduction of 360-degree cameras into the ethnographic practices of data collection and presentation.

## 6 CONCLUSION

In this study, we presented a framework for discussion on the use of 360-degree cameras in ethnography constructed on the basis of the exploration with ethnographers. By speculating about future experiences and gaining an understanding of practices, our study elicited both opportunities and challenges to ethnography. These findings relate not only to ethnographers and 360-degree cameras but also to the corresponding ecosystem including research subjects, technological interventions for ethnography, and organizations. Going forward, by drawing upon the findings of this paper, we hope that researchers and practitioners will be able to smoothly initiate discussions on ethnography with 360-degree cameras.

However, we consider our study to be a prototype based on early practices and recognize the lack of sufficient accumulation of case studies of ethnography

using 360-degree cameras. Future work will refine the framework presented in this paper by accumulating real-world experience within the field to deepen the discussion.

## REFERENCES

- Aladwan, A., Kelly, R. M., Baker, S., and Velloso, E. (2019). A tale of two perspectives: A conceptual framework of user expectations and experiences of instructional fitness apps. In *Proc. CHI '19*, pages 1–15.
- Alvero, A. M. and Austin, J. (2004). The effects of conducting behavioral observations on the behavior of the observer. *Journal of Applied Behavior Analysis*, 37(4):457–468.
- Anderson, K., Nafus, D., Rattenbury, T., and Aipperspach, R. (2009). Numbers have qualities too: Experiences with ethno-mining. *Ethnographic Praxis in Industry Conference Proceedings*, pages 123–140.
- Boletsis, C. (2018). Virtual reality for prototyping service journeys. *Multimodal Technologies and Interaction*, 2(2).
- Buur, J., Fraser, E., Oinonen, S., and Rolfstam, M. (2010). Ethnographic video as design specs. In *Proc. OZCHI '10*, pages 49–56.
- Chapman, C. N. and Lahav, M. (2008). International ethnographic observation of social networking sites. In *CHI EA '08*, pages 3123–3128.
- Coffey, A., Renold, E., Dicks, B., Soyinka, B., and Mason, B. (2006). Hypermedia ethnography in educational settings: Possibilities and challenges. *Ethnography and Education*, 1(1):15–30.
- Corbin, J. M. and Strauss, A. L. (2008). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. SAGE Publications.
- Crabtree, A., Benford, S., Greenhalgh, C., Tennent, P., Chalmers, M., and Brown, B. (2006). Supporting ethnographic studies of ubiquitous computing in the wild. In *Proc. DIS '06*, page 60–69.
- Cruz, E. G. (2017). Immersive reflexivity: Using 360° cameras in ethnographic fieldwork. In Cruz, E. G., Sumartojo, S., and Pink, S., editors, *Refiguring Techniques in Digital Visual Research*, pages 25–38. Palgrave Macmillan, London, UK.
- Dunne, A. and Raby, F. (2013). *Speculative Everything: Design, Fiction, and Social Dreaming*. The MIT Press.
- Emmison, M., Smith, P., and Mayall, M. (2012). *Researching the Visual (Second Edition)*. SAGE Publications.
- Faklaris, C., Cafaro, F., Blevins, A., O'Haver, M. A., and Singhal, N. (2020). A snapshot of bystander attitudes about mobile live-streaming video in public settings. *Informatics*, 7(2).
- Goodman, L. A. (1961). Snowball sampling. *The Annals of Mathematical Statistics*, 32(1):148–170.
- Hebbel-Seeger, A. (2017). 360 degrees video and VR for training and marketing within sports. *Athens Journal of Sports*, 4(4):243–261.
- Jokela, T., Ojala, J., and Väänänen, K. (2019). How people use 360-degree cameras. In *Proc. MUM '19*.
- Kasahara, S., Nagai, S., and Rekimoto, J. (2014). Live-sphere: Immersive experience sharing with 360 degrees head-mounted cameras. In *Proc. UIST'14 Adjunct*, pages 61–62.
- Kostakos, P., Alavesa, P., Oppenlaender, J., and Hosio, S. (2019). VR ethnography: A pilot study on the use of virtual reality 'go-along' interviews in Google street view. In *Proc. MUM '19*.
- Larcher, J. and Oxley, N. (2015). Current dilemmas of the ethnographer behind the camera. *Anthrovision*, 3(2).
- Lee, B., Lee, M., Zhang, P., Tessier, A., Saakes, D., and Khan, A. (2019). Skeletonographer: Skeleton-based digital ethnography tool. In *CSCW '19 Companion*, pages 14–17.
- Lemke, J. L. (2002). Travels in hypermodality. *Visual Communication*, 1(3):299–325.
- Marshall, C. and Rossman, G. B. (2001). *Designing Qualitative Research (Sixth Edition)*. SAGE Publications.
- Mendonca, K. and Ray, A. (2017). Immersive perspectives: Virtual reality and ethnographic research. *Ethnographic Praxis in Industry Conference Proceedings*, 2017(1):499.
- Murray-Rust, D., Gorkovenko, K., Burnett, D., and Richards, D. (2019). Entangled ethnography: Towards a collective future understanding. In *Proc. HTTF '19*.
- Murthy, D. (2008). Digital ethnography: An examination of the use of new technologies for social research. *Sociology*, 42(5):837–855.
- Paay, J., Kjeldskov, J., and Skov, M. B. (2015). Connecting in the kitchen: An empirical study of physical interactions while cooking together at home. In *Proc. CSCW '15*, pages 276–287.
- Patton, M. Q. (2002). *Qualitative Research & Evaluation Methods (3rd Edition)*. SAGE Publications.
- Pink, S., Horst, H., Postill, J., Hjorth, L., Lewis, T., and Tacchi, J. (2015). *Digital Ethnography: Principles and Practice*. SAGE Publications.
- Postill, J. and Pink, S. (2012). Social media ethnography: The digital researcher in a messy web. *Media International Australia*, 145(1):123–134.
- Singhal, S., Neustaedter, C., Schiphorst, T., Tang, A., Patra, A., and Pan, R. (2016). You are being watched: Bystanders' perspective on the use of camera devices in public spaces. In *CHI EA '16*, pages 3197–3203.
- Spradley, J. P. (2016). *Participant Observation*. Waveland Press.
- Thoring, K. C., Mueller, R. M., and Badke-Schaub, P. (2015). Ethnographic design research with wearable cameras. In *CHI EA '15*, pages 2049–2054.
- White, M. (2009). Ethnography 2.0: Writing with digital video. *Ethnography and Education*, 4(3):389–414.