Improving Collaboration and Shared Experiences in Out-and-About Mobile Video Conferencing

Brennan Jones
Dept. of Computer Science
University of Calgary
bdgjones@ucalgary.ca

Anthony Tang
Dept. of Computer Science
University of Calgary
tonyt@ucalgary.ca

Abstract
Video conferencing allows people to collaborate and share experiences across a variety of work and play-related scenarios. Mobile video conferencing enables entirely new usage scenarios where one or more parties are physically moving around in a large activity environment. One major benefit of mobile devices is that they can potentially support activities that focus on large environments—activities such as searching, navigating, and touring. However, today's mobile video conferencing tools are not designed to support such activities. We discuss potential design ideas for mobile video conferencing tools that could better support these kinds of activities.

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CSCW; collaboration; shared experiences; video conferencing; mobile devices

ACM Classification Keywords
H.5.3. Information interfaces and presentation (e.g., HCI): Group and Organization Interfaces – *Computer-supported cooperative work*

Introduction

Video conferencing is becoming an increasingly popular means for people to connect, collaborate, and share experiences across a variety of scenarios, including (but not limited to) group meetings, classes, and family get-togethers. Mobile video conferencing, in particular, enables entirely new scenarios of use where one or more participants are "out and about" physically moving around "in the real world." Such scenarios include assisting someone with a physical task (such as maintenance, construction, or repair) [3, 4], searching for something together (for example, in a retail outlet or on a diagram), giving someone a tour of a new environment [10], and sharing outdoor experiences [8].

Many of these activities require active participation from both parties. They require both parties to make references and direct attention towards certain things in the environment where the activity is taking place, and they require both parties to have a strong awareness of that environment. However, contemporary mobile video conferencing tools make it difficult for users to achieve either of these; rather, they are designed too much like their desktop counterparts.

Related Work

Mobile Video and Shared Experiences

Previous work has investigated the use of mobile video conferencing in sharing experiences across a distance. These can be personal, family, and outdoor experiences.

Inkpen et al. [6] ran a study exploring the use of video conferencing technologies to share kids' events occurring outside the home. The researchers found that providing multiple camera views helped in making the remote person feel like they were included in the shared activity. By doing so, the remote person was able to observe both the activity and the local parents' reactions.

Procyk et al. [8] explored the use of video conferencing for remote geocaching. Their focus was on parallel experiences—where both the local and remote user are engaged in the same activity at the same time. The researchers had pairs of people who knew each other participate in shared geocaching activities across a distance using a wearable video conferencing technology probe. Their results showed that, while participants became strongly engaged in the shared experience, this strong engagement led to participant distraction. The authors also make mention to privacy concerns and the awkwardness of participating in mobile video calls while in public.

Mobile Video and Collaboration

Gauglitz et al. [3] and Kasahara et al. [7] both propose remote pointing and referencing of objects in the mobile scene as a means of improving collaboration in mobile video conferencing. Gauglitz et al. [3] explore this by allowing a remote user to place markers on objects in the local video frame; these markers move in the video frame with the object that they were originally placed on. Kasahara et al. [7] explore displaying such references through a transparent head-mounted display.

While these and other previous works have investigated means of improving collaboration in mobile video conferencing with regards to physical tasks where the

Figure 1: The 360cam [1], a consumer-level 360º camera.

workspace is relatively small, very little research has explored mobile video collaboration with regards to activities that focus on large environments—activities such as searching, navigating, and touring. One major benefit of mobile devices is that they can potentially provide users the freedom to engage in video conferencing while performing such activities. Unfortunately, current technologies fall short in their abilities to support these kinds of activities.

Work Done

During the summer of 2014, we ran an observational study investigating how pairs of collaborators—one at a desk and the other "out and about"—interact and work together through mobile video conferencing. We looked to see what collaborators' communicative intentions were and what types of problems they encountered when trying to interact through a video call. We had pairs of collaborators complete four different tasks together, each with one person out in the field and the other at a desk. These tasks varied in terms of their goals, the knowledge of each collaborator, the amount of physical movement necessary, the distance between targets (e.g., objects of interest that a collaborator in the activity environment might want to share), and the amount and types of camera movement necessary. The results of this study provide interesting insights.

For example, we found that desk-bound collaborators had a very limited ability to look around freely in the mobile scene. What they saw was restricted to what the mobile collaborator showed them. This significantly hindered pairs' abilities to work together in tasks that involved searching and navigating. In some of these tasks, some mobile collaborators took complete control; during which time desk-bound collaborators made very few interjections and attempts to direct the mobile collaborator's attention towards something specific in the environment.

Potential Design Ideas

One of the major issues with regards to current mobile video conferencing technologies is that they provide the remote collaborator with limited awareness of the activity environment. The remote collaborator's view into the activity environment is a low field-of-view (FOV) shot that he/she has no direct control over. As a result, it can be difficult for parties to work and play together through such technologies. Our goal is to design mobile video conferencing tools that address this issue.

One possible design idea for a tool that could address this issue is one that makes use of a 360º camera (e.g., [1]) to give the remote party a high-resolution and wide FOV look into the activity environment. This system could utilize a 360º camera on the mobile end and allow the participant on the desktop end to control their view of the mobile environment on their own (e.g., by dragging the video frame around).

Another idea could be to reconstruct large environments in some way to allow the remote collaborator to explore the environment freely. Scene reconstruction in video conferencing has been explored to some extent by other researchers (e.g., [4, 7]). However, most of what has been done so far is with regards to small workspaces and scenes shot from specific focal points. Giving the remote collaborator the ability to explore a reconstructed environment freely from multiple locations and multiple camera angles could be beneficial. This could be done, for example, by

Figure 2: The Parrot AR.Drone [2].

providing the remote collaborator an interface similar to Google Street View [5], where they could rotate their camera view and explore the environment to the extent that the local collaborator's mobile device captured it.

Sakata et al. [9] explored the idea of giving the remote collaborator the ability to control a camera worn on a local collaborator's shoulder. It would also be interesting to see if giving the remote collaborator the ability to move the camera around freely in the environment—perhaps by attaching it to a telepresence robot—provides any additional benefit. In addition, attaching the camera to a robot that could fly (e.g., the Parrot AR.Drone [2]) could allow the remote collaborator to help out in ways that a second local partner would not be able to by being able to see the activity environment from angles impossible to reach from the ground.

Conclusion

Mobile devices have the potential to provide users the freedom to engage in video conferencing while taking part in activities that focus on large environments. However, today's mobile video conferencing tools are not designed to support such activities—rather, they are designed too much like their desktop counterparts. In particular, they provide the remote party with limited awareness of the activity environment and limited ability to control their view of the activity environment. This hinders the remote party's ability to participate in activities such as searching, navigating, and touring; and it can also make the experience quite frustrating for the local party. We hope to explore design ideas for mobile video conferencing tools that better support activities that focus on large environments.

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