# BeWithMe: An Immersive Telepresence System for Distance Separated Couples

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## Abstract

Current telepresence systems are limited by the use of standard, narrow field-of-view cameras and are mainly designed to support indoor conversations. We propose a novel immersive telepresence system designed for long distance couples called "BeWithMe" which presents the entire 360-degree view of a partner's location with an independent perspective to control the view. We expect couples to use the system for sharing their daily activities, experiences, and to gain an understanding of each other's physical space. In this paper, we will explain the overview of the design principles, system design, and discuss the viewing experience.

## Author Keywords

Omnidirectional video, 360-degree video, immersive, telepresence;

## ACM Classification Keywords

H.5.1 Information Interfaces and Presentation (I.7): Multimedia Information Systems- Artificial, augmented, and virtual realities, video;

## Introduction

Long-distance couples stay connected on a regular basis by relying heavily on communication technologies
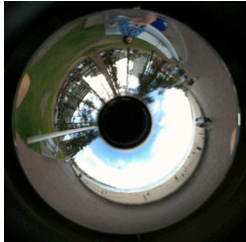
Figure 1 a) Omni-directional Image



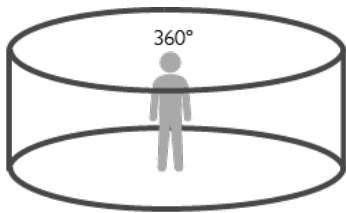Figure 1 b) Cylindrical projection of omnidirectional image



Figure 2: Cylindrical Image Perspective of Omni-directional Video.

and sharing their daily experiences when they meet each other in person [4,8]. Yet some couples are separated by distance, which causes computer-mediated communication to become critical for maintaining their relationship [1,8]. Face-to-face video communication is widely used to support their needs. However, the challenge with these systems is that they typically support a limited field of view, mostly confined to an indoor space and focus on conversations for the sole use of the system when, in reality, couples may wish to do far more over a video connection. Video communication presents a large quantity and diversity of information in a short span of time. With Omni-directional video (ODV) we can cover the entire 360-degree field of view (FOV) in the horizontal plane, as opposed to a standard narrow FOV camera (figure 1). They provide an immersive experience as if the person is present inside the view [6] impacting their emotions, and especially arouses their sense of presence and engagement [11] as shown in Figure 2.

In this paper, we present BeWithMe, an immersive telepresence system for long distance couples. This system was designed with the goal of immersing remote partners into each other's location so they feel a greater sense of presence in the remote environment. We describe our design principles, implementation and critique our design from couple's perspective.

## Related Work
Many couples rely on video communication to stay connected [4,8,9]. Video communication tools are increasingly important for connecting couples over distance and can increase feelings of closeness, build trust, and improve relationship satisfaction [2]. Video

communications are now occurring in settings outside of the home such as for major life events including weddings, parties, and funerals [9]. Research has shown that mobile cameras can be challenging to use for such activities and require extra efforts by the camera person to provide a good view of the remote location [5]. Earlier attempts to provide a wide FOV [3,6] of the remote person's environment have identified concerns around image quality, frame rates, and expensive hardware [6] that is difficult to use in a mobile context. This makes these systems difficult to use in outdoor settings or means that they do not support live video streaming. Overall, our research builds on the related work carried out by researchers to understand how to design an immersive video communications technology for couples that can allow them to stay connected throughout the day in indoor or outdoor settings.

## Design Requirements
The design of our system is based on four principles:
*1) Mobile and Flexible*: We want partners to be part of each other's experience and witness the remote location in nearly any location. Building this system on a smartphone platform would encourage anytime and anyplace communication for couples.

**2) Omnidirectional View**: Massimi et al [7] and Jones et al [5] described how it is difficult for people to understand a remote location's physical geography, mainly due to the limited FOV found in smartphone cameras. To capture the entire 360-degree horizontal plane of view (panoramic view), we used a hyperboloidal lens—GoPano micro [12]—that easily fits a smartphone camera and provides a large FOV.
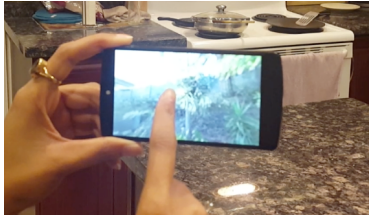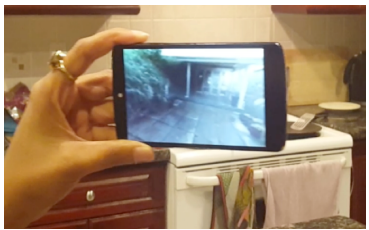
Figure 3a: Navigation using touch



Figure 3b: Navigation using the rotation of device



Figure 3c: Navigation using rotation of the head

**3) Effective Interaction**: ODV covers the entire 360 horizontal plane though it cannot be viewed as-is [10] due to the limitation of human vision. We wanted to provide flexible interactive mechanisms that allow the user to navigate the video with a greater control over the contents they want to view. We implemented three ways of navigating: a) touch-screen control (Figure 3a), b) rotation of device (Figure 3b), and c) an immersive display, with perspective control, through head rotation (Figure 3c).

**4) Independent Navigation:** In mobile video communications, the remote view has always been controlled by the sender. ODV presents the entire 360 video to the user at any time, and, hence, the viewer can dynamically view any portion of the remote video. This would provide the viewer with an independent navigation of the remote context at any point in time.

## System Design & Implementation

The partner sharing his/her view attaches the GoPano lens to their Smartphone to share their environment as shown in Figure 4a. The partner viewing the remote context will see the 360-degree rendered view on a mobile screen. This partner would be able to move and pan in the remote context with the help of a gyroscopic sensor on the smartphone (it measures rotational motion and orientation changes of a device). This will allow the viewer to understand and explore their remote partner's view with an independent perspective. This view can be seen on a VR headset like Google Cardboard as shown in Figure 4b. This will provide the user with a greater sense of immersion as they can now move their head in their own space to explore the remote context.

The system first captures the Omnidirectional video through the GoPano lens [12] which is converted to a cylindrical projection using the OpenCV Image processing library. This cylindrically shaped video is transmitted to a server using Real-Time Message Protocol and later delivered to the remote user using Http Live Streaming. On the remote end, there are three ways to interact with the video based on touch and movement of their smartphone. To make the viewing experience more immersive, we rendered this omnidirectional video on a VR headset using the same mobile device.

*Usage Scenario*
We imagine couples would want to do a variety of activities together using our system. One of the scenarios may look like this: *Tim and Liz are in a long-distance relationship and both used to go hiking together in Sweden. Liz has now moved to Vancouver, Canada where she goes hiking and shares her hiking experience with the help of BeWithMe. She takes out her Smartphone, attaches the 360 lens, and shares her hiking experience with Tim. On the other side, Tim simply uses a Google Cardboard mount with his Smartphone. He moves his head around his own physical space as if he is looking through Liz's eyes to navigate the 360-degree view of her hiking experience making Tim a part of the hike. Tim helps Liz by suggesting directions to take by looking around the 360-degree view without having to ask Liz to move the camera.*

## Conclusion

Our goal for BeWithMe was to immerse a person into their partner's location so that they could get a greater sense of presence and understanding of their partner's
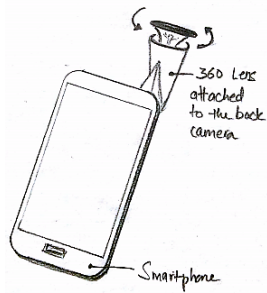
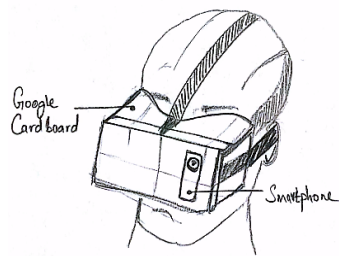Figure 4: Components of BeWithMe (a) GoPano lens attached to Smartphone



Figure 4 b) Google Cardboard viewer

physical environment. With the use of an omnidirectional lens and simply looking around one's own space, users could see their partner's 360-degree view. This makes the system flexible and easy to use during an outdoor activity. With BeWithMe couples can be a part of each other's experience, witnessing it in-time with them rather than re-living a narrative version of the experience after it has happened through recorded video. This could help couples living apart to understand each other's changing needs and desires over time. The three interaction modes provide a greater spatial awareness of a partner's environment and allow users to switch to any one of the modes based on their needs. Overall, we feel this work presents a stark contrast with the design of existing video communication systems, which are constrained to narrow fields of view and are overly focused on supporting conversations as opposed to sharing activities and experiences remotely.

## References

1. Almond Pilar N. Aguila. 2011. Living Long Relationships through Computer-Mediated Communication. *Social Science Diliman* 5, 1&2.

2. Marianne Dainton and Brooks Aylor. 2002. Patterns of communication channel use in the maintenance of long-distance relationships. *Communication Research Reports* 19, 2: 118–129.

3. Luis Gaemperle, Kerem Seyid, Vladan Popovic, and Yusuf Leblebici. 2014. An Immersive Telepresence System Using a Real-Time Omnidirectional Camera and a Virtual Reality Head-Mounted Display. 175–178.

4. Saul Greenberg and Carman Neustaedter. 2013. Shared Living, Experiences, and Intimacy over Video Chat in Long Distance Relationships. In *Connecting Families*, Carman Neustaedter, Steve Harrison and Abigail Sellen (eds.). Springer London, London, 37–53.

5. Brennan Jones, Anna Witcraft, Scott Bateman, Carman Neustaedter, and Anthony Tang. 2015. Mechanics of Camera Work in Mobile Video Collaboration. 957–966.

6. Shunichi Kasahara, Shohei Nagai, and Jun Rekimoto. 2014. LiveSphere: immersive experience sharing with 360 degrees head-mounted cameras. 61–62.

7. Michael Massimi and Carman Neustaedter. 2014. Moving from Talking Heads to Newlyweds: Exploring Video Chat Use During Major Life Events. In *Proceedings of the 2014 Conference on Designing Interactive Systems* (DIS '14), 43–52.

8. Carman Neustaedter and Saul Greenberg. 2012. Intimacy in Long-distance Relationships over Video Chat. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '12), 753–762.

9. Carman Neustaedter, Carolyn Pang, Azadeh Forghani, Erick Oduor, Serena Hillman, Tejinder K. Judge, Michael Massimi, and Saul Greenberg. 2015. Sharing Domestic Life Through Long-Term Video Connections. *ACM Trans. Comput.-Hum. Interact.* 22, 1: 3:1–3:29.

10. Benjamin Petry and Jochen Huber. 2015. Towards effective interaction with omnidirectional videos using immersive virtual reality headsets. 217–218.

11. Valentijn T. Visch, Ed S. Tan, and Dylan Molenaar. 2010. The emotional and cognitive effect of immersion in film viewing. *Cognition & Emotion* 24, 8: 1439–1445.

12. GoPano. Retrieved from www.gopano.com