



## I-Portrait: An Interactive Photograph System for Enhancing Social Presence

Seungwan Ha & Jusub Kim

To cite this article: Seungwan Ha & Jusub Kim (2019) I-Portrait: An Interactive Photograph System for Enhancing Social Presence, International Journal of Human-Computer Interaction, 35:20, 1906-1913, DOI: [10.1080/10447318.2019.1580858](https://doi.org/10.1080/10447318.2019.1580858)

To link to this article: <https://doi.org/10.1080/10447318.2019.1580858>



Published online: 01 Mar 2019.



Submit your article to this journal [↗](#)



Article views: 144



View related articles [↗](#)



View Crossmark data [↗](#)



# I-Portrait: An Interactive Photograph System for Enhancing Social Presence

Seungwan Ha and Jusub Kim

Department of Art and Technology, Sogang University, Seoul, Republic of Korea

## ABSTRACT

People often strive to “externalize” memories for long-term saving or sharing with others using different forms of media. We devised a new interactive photograph system, *I-Portrait*, which enables interactive experiences with figures in a photograph. *I-Portrait* comprises short video clips that are recorded and played upon user interactions such as touch, voice, gestures, and facial expressions, providing users with the virtual experience of interaction with the figure. We evaluated the system by surveying 40 university students (age 20–29 years) on the level of social presence of the photograph (mutual awareness, emotional connectedness, and awareness of co-location) and users’ satisfaction, and comparing these measures between the *I-Portrait* system and traditional portraits. We found significant differences in all aspects of social presence suggesting that the interactivity of the *I-Portrait* system may significantly increase the social presence of physically distant others.

## 1. Introduction

The practice of “externalizing” memories using different forms of media (e.g., drawings, pictures, videos) for long-term saving or sharing with others is a common human practice. Throughout the twentieth century, the photograph (invented by Joseph Nicéphore Niépce in 1826), reigned supreme as the chosen medium for saving and sharing memories. With the advent of smartphones with built-in cameras in the early 21<sup>st</sup> century, photographs have also become the primary digital medium for memories (Ji, 2016).

In the age of analog photography, photographs were primarily used to store autobiographical memories (Van Dijck, 2008). However, with the introduction of digital photographs – and particularly the fact that they can be instantly viewed, edited, and shared – photographs are nowadays used more in forming and maintaining social relations (Van Dijck, 2008), especially when used in conjunction with social media (e.g., Instagram, Facebook, Twitter). People use social media to interact with others via text, photographs, and videos. Photographs in particular are often used as a form of self-expression in a way similar to words in face-to-face conversation, and can help in forming new relationships or strengthening existing ones (Gye, 2007; Kindberg, Spasojevic, Fleck, & Sellen, 2005; Van House, Davis, Ames, Finn, & Viswanathan, 2005).

However, the digitization of photographs has done little to change the way we actually experience photographs. For instance, variability – a defining characteristic of digital media – is present primarily in the correction stage (e.g., immediate color correction) to produce better photographs, and does not much influence how individuals experience the photographs. In other words, the way that users currently

experience photographs, even digital ones, is limited to merely “seeing” directly stored or shared pictures, much like in the nineteenth century. Photographs cannot, for example, allow individuals to actually interact with the figures depicted, meaning that photography remains limited as an interactive medium.

In this paper, we suggest a new memory media system, *I-Portrait*, which enables users to actually interact with a figure in the photograph. *I-Portrait* comprises short video clips that are recorded and played when the user interacts with a portrait (e.g., via touch, voice, gestures, and facial expressions), thus providing users with the virtual experience of interacting with the portrait’s figure. We then evaluated the system in comparison to a traditional portrait by asking users to rate the *social presence* of the portrait’s figure (mutual awareness, emotional connectedness, and awareness of co-location) and their satisfaction with the portrait. We were also interested in which of the subfactors of social presence relate to users’ overall satisfaction. The remainder of this paper is organized as follows: a literature review, a description of the system and evaluation methods, the results, and the conclusion.

## 2. Related work

In this section, we review previous studies on interactive photography, the social roles of photographs, and social presence.

### 2.1. Interactive photography: Photographs and interactive media

Memory is crucial for humans, as it enables us to learn how to use language and tools on a personal level and contributes to the

development of human society as a whole on a social level. People are largely aware of the importance of memory, which is perhaps what prompts them to try to externalize memories through various media – that is, doing so can help “store” memories for long periods as well as ease in the sharing of memories. Painting has been the primary mode of memory externalization (i.e., storing or sharing memories) for much of human history, although this has recently progressed into photography and videography. Photographs have proven to be especially important in storing and sharing memories (Van Dijck, 2007). With the emergence of mobile phones with built-in cameras in the twenty-first century, photographs can nowadays be taken anytime and anywhere for any purpose (e.g., personal or family use). The increasing availability and popularity of photography has also led to the introduction of smartphone applications for organizing, decorating, and sharing photographs. The convenience of editing and sharing photographs without cost has effectively enabled photographs to take the place of words in conversation, making them tools for self-expression (Beldad & Hegner, 2017; Van House, 2009), and initiating and strengthening relationships (Gye, 2007; Kindberg et al., 2005; Van House et al., 2005). In terms of strengthening relationships, photographs contribute to the enhancement of emotional connectedness and feelings of co-location (Rivière, 2005).

In the past, letters and telephones were analog forms of interactive media. However, technological advancements have expanded the range of interactive media considerably – nowadays, we have video conferencing technology, games, and social media (Markus, 1990). Before going any further, it is vital to define what is meant by interaction, the interactivity of media, and interactive media as a whole. Here, interaction can be understood as “a cyclic process in which two actors alternately listen, think, and speak” (Crawford, 2002, p. 5), “a cycle of communication acts” (Hornbæk & Oulasvirta, 2017, p. 3), and “acting and being in situations of a material and social world” (Hornbæk & Oulasvirta, 2017, p. 5), invoking emotion (Brave & Nass, 2003). In the interaction situation, people convey their emotions (i.e., love, anger, fear) through touch (Hertenstein, Keltner, App, Bulleit, & Jaskolka, 2006), facial expression (Ekman, 1993), gesture (Friedman & Riggio, 1981), voice (Scherer, 1995). Interactivity, on the other hand, is used specifically in the context of human-computer interaction – it can be defined as “the extent to which users can participate in modifying the form and content of a mediated environment in real-time” (Steuer, 1992, p. 14) and can influence user experience variables such as social presence (Fortin & Dholakiab, 2005), satisfaction (Teo, Oh, Liu, & Wei, 2003), and preference (Chung & Zhao, 2004). Finally, interactive media can be defined as media that “allow users to control the sequence in which they access content” (Lopes, 2001, p.67) and “the digital media including combinations of electronic text, graphics, moving images, and sound, into a structured digital computerized environment that allows people to interact with the data for appropriate purpose” (England & Finney, 2011, p. 2).

In the field of interactive media, there are two main lines of research on photo media. The first line relates to various methods of organizing and modifying photographs. For instance, Santella, Agrawala, DeCarlo, Salesin, and Cohen (2006) proposed a method of cropping specific parts of an image through gaze interaction. Jin et al. (2004), on the other

hand, proposed a method of controlling the editing and placement of photographs through gestures. Davis, Chen, and Durand (2015) introduced an interactive video system wherein the structure of objects is extracted from videos and used to generate animations that respond to user interactions. These studies have explored ways of applying various forms of interaction to photographs, thereby opening the way for photography to function as interactive media.

The other line of research concerns studies that link photographic, videographic, and digital information with other media (Barthel, Kröner, & Hauptert, 2013; Kawamura, Fukuhara, Takeda, Kono, & Kidode, 2007). For example, one study involved connecting photographs or videos with real objects through radio frequency identification (RFID) and quick response (QR) codes. More specifically, photographs or videos are connected with physical objects to enable users to recall memories attached to specific objects (Kawamura et al., 2007). These studies suggest a possible new interactive photograph system without actually adding interaction.

In 2015, Apple added the “Live Photo” function, which allows users to create interactive videos on the iPhone. With this function, the user can experience photos more vividly using the touch interface – when the user touches an object in a still image, the object appears to move as if in response to the touch. However, this function can only be enabled through specific interactions – that is, tapping and Force Touch – and does not allow users to add desired interactions.

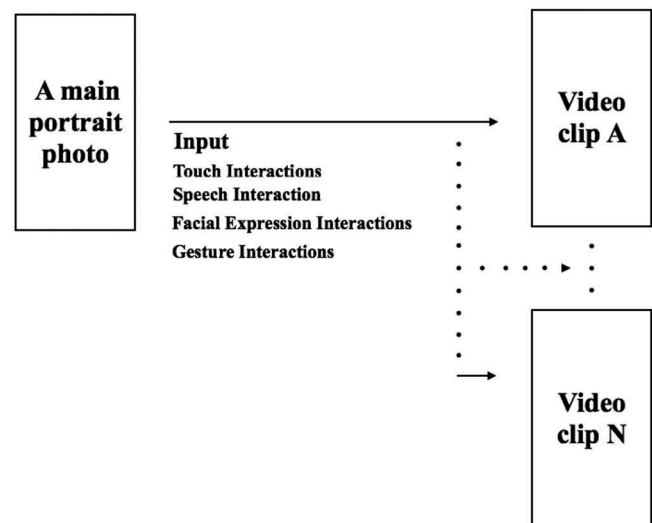
## 2.2. Social impacts of photographs and social presence

As a communication medium, photographs can have diverse impacts on interpersonal relationships. To elaborate, photographs can be used in strengthening and forming relationships (Hunt, Lin, & Atkin, 2014; Van Dijck, 2008), boosting social presence (Romero et al., 2007), promoting a sense of cooperation in a game (Zheng, Veinott, Bos, Olson, & Olson, 2002), and influencing credibility (Fogg, 2002). The presence of photographs can, for instance, influence the response of recipient of an e-mail request from an unknown person (Guéguen & Jacob, 2002). Based on these social impacts, researchers have suggested various systems – such as a digital family portrait system (Mynatt, Rowan, Craighill, & Jacobs, 2001) or photo-sharing system (Counts & Fellheimer, 2004) – that rely on photographs to enhance social awareness or social presence.

Social presence in media is a crucial variable to consider when evaluating how media affect relationships. Media high in social presence can enhance interpersonal relationships (Yoo & Alavi, 2001), closeness (Gooch & Watts, 2015), social interaction (Tu & McIsaac, 2002), and satisfaction (Richardson & Swan, 2003). According to past studies, media that can “convey non-verbal information (such as facial expressions, posture, gaze)” is rated as high in social presence (Peters, 1998, p. 24). Social presence markedly differs from physical presence (Lombard & Ditton, 1997), which is defined as “the sense of the place” (Biocca, Harms, & Burgoon, 2003, p. 456), and is considered a main factor in the design and evaluation of media content in VR-based entertainment, education, healthcare, and computer interface design.

The definition of social presence varies widely. Short, Williams, and Christie (1976) defined social presence as “the degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships” (Short et al., 1976, p. 65). In other studies, social presence is defined as a “sense of access to another mind” (Nowak & Biocca, 2003, p. 4), a “psychological degree to which one perceives the presence of and connectedness with others” (So & Brush, 2008, p. 323), and a “sensation of being with other selves” (Riva & Mantovani, 2014, p. 18). Biocca et al. (2003) classified the definitions of social presence into three primary themes: 1) co-presence; co-location and mutual awareness, 2) psychological involvement including intimacy & immediacy, and 3) behavioral engagement. Rettie (2003) suggested the logical relationship between the concepts of social presence, awareness, and connectedness and argued that connectedness is a more fundamental concept in the analysis of communication technology. Rettie (2003) argued that the concept of connectedness is related to the concept of social presence, but they are not equivalent. On the other hand, IJsselstein, van Baren, and van Lanen (2003, p. 927) proposed that the concepts of social presence and connectedness are complementary, arguing that in an awareness system the level of social presence will be very low, but “the sense of connectedness, the feeling of being in touch can be strong.” Based on prior research on social presence, Hwang and Park (2007) defined social presence as a sense of “being together” in a mediated communication by relating social presence to mutual awareness, connectedness, and co-location. In this paper, we mainly refer to the Hwang and Park (2007)’s definition of social presence.

The diversity of its definitions has similarly given rise to a plethora of different methods of measuring social presence. Short et al. (1976) evaluated social presence on a range of dimensions, including warm/cold, personal/impersonal, sensitive/insensitive, and sociable/unsociable, in an attempt to determine whether media with high social presence is warmer and more personal and sociable. However, Short et al.’s study was limited by the fact that they considered social presence as media quality. Hwang and Lombard (2006) argue that it is important to explore user experiences when measuring social presence, and suggested several items based on previous studies (Lombard & Ditton, 1997; Towell & Towell, 1997) for that purpose. Biocca et al. (2003), on the other hand, emphasize the significance of measuring the psychological connection between users and objects in media.



**Figure 1.** A set of short video clips associated with a main portrait photo. Each video is assigned a unique interaction that triggers when it is played.

In this study, we evaluated the proposed interactive media (*I-Portrait*) by measuring the social presence of the media with Hwang’s questionnaire (Hwang, 2007; Hwang & Lombard, 2006). We chose Hwang’s questionnaire because we believed that emotional connectedness was vital to the proposed system.

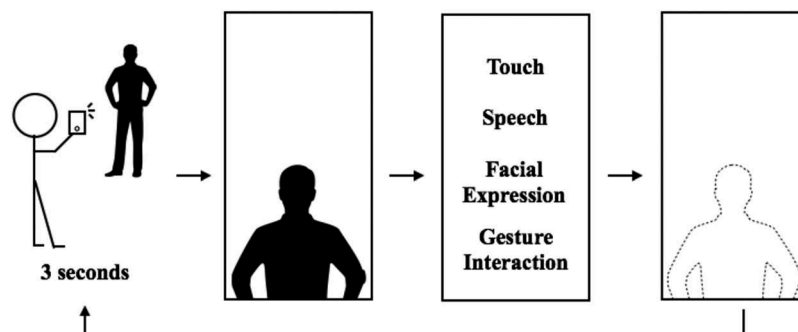
### 3. I-portrait system

#### 3.1. Overview

*I-Portrait* is a new memory media system that provides users with an interactive experience with a photographed figure. *I-Portrait* consists of short video clips that are recorded and played when users begin interacting with the portrait in various ways, such as through touch, voice, gestures, and facial expressions (Figure 1). *I-Portrait* has two major functions: recording and experiencing.

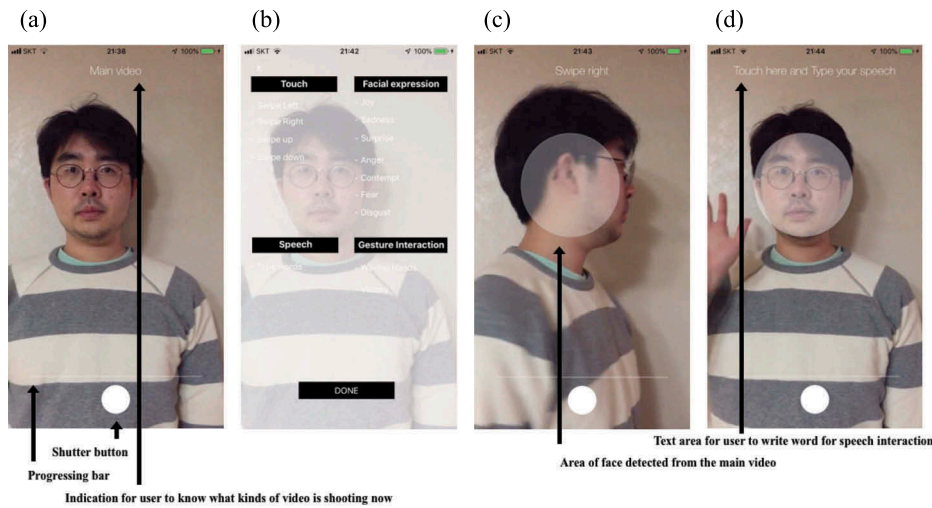
#### 3.2. Recording an *I-portrait*

The process of taking an *I-Portrait* differs from that of taking a traditional portrait photograph of a single person. *I-Portrait* users must proceed through the processes shown in Figure 2. First, the user situates the subject and presses the shutter button



**Figure 2.** Recording process: the position and size of the detected face in the first photograph are presented on the screen as visual guidelines to ensure that the figure in the first frame of all recorded videos is as similar as possible.





**Figure 3.** Recording function: (a) Recording the main portrait photo. (b) Users can create videos linked with specific interactions. (c) The view when a user wants to make a “swipe right” interaction video. (d) The view when a user wants to make a speech interaction video.

of the camera. Pressing the shutter button initiates 3 s of recording and displays a progress bar indicating how long the video has been recording. As shown in Figure 3, *I-Portrait*'s user interface (UI) is designed to resemble a typical digital camera app as opposed to a video recording app, to ensure that the user feels that they are taking a photo rather than recording a video. The position and direction of the camera must also be fixed during recording in order to ensure a smooth transition between the main photo and the associated short videos, thereby creating the illusion that users are interacting with the photos.

When the recording is completed, the user can select a specific type of interaction from among touch (i.e., swipe up, down, left, right), speech, facial expressions (i.e., joy, sadness, surprise, anger, contempt, fear, disgust), and gestures (i.e., waving hand with five fingers to greet another, expressing “victory” by forming a “v” with two fingers) to be linked with a specific video. During this process, the main photo remains in the background to help users consider a natural link between the main photo and the specific interaction video. In the case of speech recognition, the user may type in a word, after which the system plays the video whenever the user speaks the specific word aloud.

At the end of the above process, the user is asked whether they would like to take another interaction video. If they choose “no,” the shooting process is considered complete. If they choose “yes,” the above process is repeated. When a video is shot, the position and size of the detected face in the first photograph is presented on the screen as a guideline to ensure that the figure of the person in the first frame of all recorded videos is as similar as possible. The whole process of creating an *I-Portrait* can range from 5 s to 1–2 min, depending on how many interaction-related videos that they want to add and how many times they re-take the videos.

### 3.3. Experiencing an *I-portrait*

The process by which a user experiences an *I-Portrait* differs from that by which a user experiences a conventional portrait.

First, each *I-Portrait* is displayed in a gallery as thumbnails of the first frame of the first video. Upon choosing a specific

thumbnail, the corresponding *I-Portrait* is displayed on the full screen in a standby mode awaiting the user's interactions.

When an interaction is recognized, the system checks whether a corresponding video exists. When it does not exist, it displays a list of recognizable interaction as shown in Figure 5. When such a video does exist, the photograph switches to the corresponding video. To enhance users' feeling that they are interacting with the figure in the photograph in real time, the dissolve effect is used to switch between the photograph and video. In addition, users can opt to make the video played in the reverse direction after played forward to minimize the break phenomenon that happens because the last frame of the interaction video and the main photo differ. After one playback, the main portrait video appears again in standby mode (Figure 4).

Sharing *I-Portraits* with others requires both the sender and receiver to have the *I-Portrait* app on their smartphone, given the unique way of experiencing the photos (as described above).

### 3.4. Implementation details

*I-Portrait* was developed using Xcode 10.0, Swift 4, and Objective-C for iOS devices. Table 1 shows the software libraries used to implement the various interactions in this study.

## 4. Evaluation

We evaluated the proposed interactive photograph system in terms of the level of social presence of the media. Specifically, we measured three subfactors of social presence considered most relevant for our purposes: mutual awareness, emotional connectedness, and awareness of co-location. Table 2 displays the questions for measuring these social presence factors.

### 4.1. Participants

We recruited 40 students from Sogang University in their 20s as participants (mean age: 24.8 years, age range: 20–29 years, 20 men and 20 women). Each group's participant demographic information is shown in Table 3.

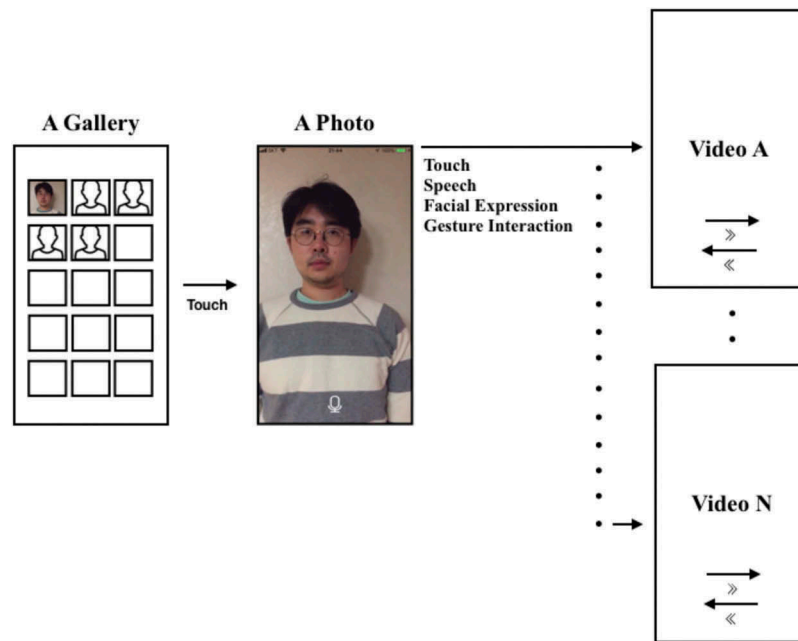


Figure 4. Experiencing process: various user interactions are detected, causing the associated short videos to play with dissolve effects and forward/reverse play.

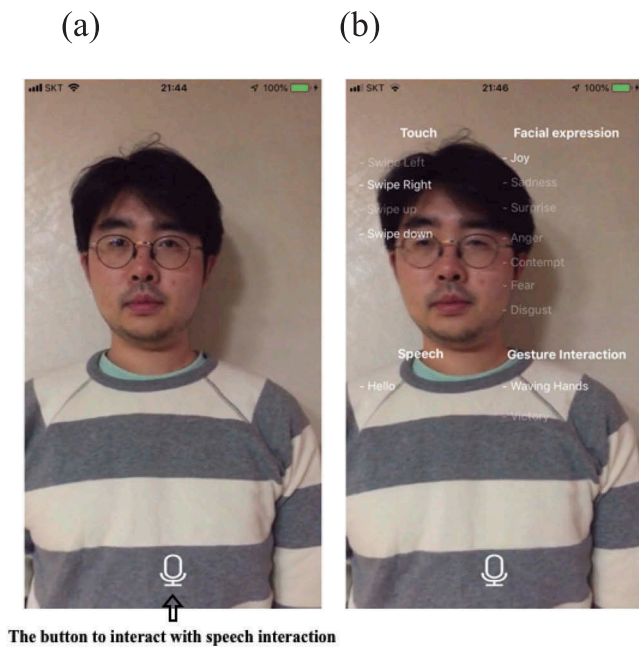


Figure 5. Experience function: (a) The standby mode allowing interactions and the button for initiating speech interaction. (b) The list of available interactions that users can use for interacting with the subject in a given I-Portrait.

Table 3. Participants' demographic information.

Group	Male	Female	Age		
	n	n	Range	M	SD
Traditional Portrait Photograph Group	10	10	21–29	25	2.384
I-Portrait Group	10	10	20–29	24.6	2.683

Table 1. Software libraries used for interaction.

Interaction Types	Software Library
Touch	Apple UIKit Framework
Speech	Apple Speech Framework
Facial Expressions (Joy, Sadness, Surprise, Anger, Contempt, Fear, Disgust)	Affectiva Emotion SDK
Facial Position and Area Detection	Apple Vision Framework
Gesture	OpenCV

Table 2. Questions for measuring social presence.

Factors	Questions
Mutual Awareness	<ul style="list-style-type: none"> <li>I was able to feel my partner's presence.</li> <li>I sometimes felt alone during the experiment.</li> </ul>
Emotional Connectedness	<ul style="list-style-type: none"> <li>I tried to engage in personal communication with my partner.</li> <li>I felt that we (my partner and I) were close.</li> <li>I felt an emotional connection with my partner.</li> </ul>
Awareness of Co-Location	<ul style="list-style-type: none"> <li>I felt that my partner and I were in the same place.</li> <li>I felt as if my partner was in front of or next to me.</li> </ul>

Notes: The above questions were selectively extracted from those used in previous studies (Hwang, 2007).

## 4.2. Design

In this study, we randomly assigned participants to two independent groups: those experiencing traditional portrait photographs (just the main standby photo of the I-Portrait) and those experiencing *I-Portraits* (where the touch, facial expression, gesture, speech interaction videos were available). After being exposed to each medium with the same device (iPhone 6s), the participants were asked to respond to the questionnaires.

### 4.3. Procedure

Both groups had the same procedure: participants visited the experiment room separately at a scheduled time, received a brief introduction to the experiment, were presented with each medium for 3 min, and then answered the questions in Table 2. The traditional portrait photo and *I-Portrait* were both of a child with which the participant was unacquainted. We chose as a school-age child as the subject of the portraits to minimize individuals' resistance to interacting with an unknown person. Participants assigned to the *I-Portrait* group were allowed to engage in interactions unrestrictedly during the given time.

After exposure to the photographs, both groups rated the level of social presence (mutual awareness, emotional connectedness, and awareness of co-location) of the photographs and their overall level of satisfaction on a seven-point Likert scale ranging from 1 ("highly dissatisfied") to 7 ("highly satisfied").

### 4.4. Analysis

Using SPSS, Independent t-tests were used to examine the group difference in mutual awareness, emotional connectedness, awareness of co-location, and overall satisfaction. We also examined whether the subfactors of social presence were associated with overall satisfaction via multiple linear regression analysis.

## 5. Results

Table 4 shows the differences in subfactors of social presence and overall satisfaction between the two groups. First, for all three subfactors, we observed statistically significant differences between the groups. Emotional connectedness showed the greatest difference (mutual awareness:  $t(39) = 2.46$ ,  $p = .018$ ; emotional connectedness:  $t(39) = 6.77$ ,  $p < .001$ ; awareness of co-location:  $t(39) = 3.53$ ,  $p = .001$ ). We also observed a significant difference in overall satisfaction between the two groups ( $t(39) = 5.77$ ,  $p < .001$ ). More specifically, the *I-Portrait* group reported higher scores in all three subfactors and overall satisfaction compared to the traditional portrait photograph group: mutual awareness ( $M = 4.45$ ,  $SD = 1.18$  vs.  $M = 3.52$ ,  $SD = 1.23$ , respectively), emotional connectedness ( $M = 5.22$ ,

**Table 4.** Social presence and overall satisfaction in two groups.

	Traditional Portrait Photograph Group	<i>I-Portrait</i> Group		Sig. (2-tailed)
	<i>M(SD)</i>	<i>M(SD)</i>	<i>t</i>	
Mutual Awareness	3.52(1.23)	4.45(1.18)	$t(39) = 2.46$	.018*
Emotional Connectedness		2.89(1.22)	$t(39) = 6.77$	
			(0.96)	
Awareness of Co-Location	2.48(1.26)	4.08(1.62)	$t(39) = 3.53$	.001**
Satisfaction	3.33(1.35)	5.35(0.81)	$t(39) = 5.77$	<.001***

Notes: \*\*\* $p < .001$ , \*\* $p < .01$ , \* $p < .05$ .

**Table 5.** Association between social presence and overall satisfaction (*I-Portrait* Group).

Dependent Variable	Independent Variable	<i>B</i>	<i>Std. Error</i>	$\beta$	<i>t</i>	$R^2$	<i>F</i>
Overall Satisfaction	Mutual Awareness	-.02	.17	-.02	-.10	.413	3.76*
	Emotional Connectedness	.16	.18	.19	.91		
	Awareness of Co-Location	.28	.13	.55	2.12*		

Notes: \* $p < .05$ .

$SD = 0.96$  vs.  $M = 2.89$ ,  $SD = 1.22$ ), awareness of co-location ( $M = 4.08$ ,  $SD = 1.62$  vs.  $M = 2.48$ ,  $SD = 1.26$ ), and overall satisfaction ( $M = 5.35$ ,  $SD = 0.81$  vs.  $M = 3.33$ ,  $SD = 1.35$ ).

Multiple linear regression analysis was performed to determine the effects of social presence factors (mutual awareness, emotional connectedness, awareness of co-location) on overall satisfaction scores in the *I-Portrait*. The results of the regression (Table 5) indicated that it was statistically significant model and the three social presence factors explained 41.3% of the variance ( $R^2 = 0.41$ ,  $F(3, 16) = 3.76$ ,  $p < .05$ ). The analysis suggested that awareness of co-location ( $\beta = .55$ ) was the most influential predictor and mutual awareness ( $\beta = -.02$ ) was the least influential predictor in the model. Awareness of co-location ( $t = 2.12$ ,  $p < .05$ ) was also shown to be statistically significant predictor of satisfaction. Tests for multicollinearity indicated that a very low level of multicollinearity was present (*VIF* for all three factors  $< 1$ ).

We also posed additional questions to the *I-Portrait* group to further clarify their interaction experience. Participants reported that the tap interactions created the greatest feeling of social presence, followed by the swipe, speech, and facial expression interactions. The gesture interaction led to the lowest indication of social presence. In a subjective report of their overall interaction experience, the most frequently repeated phrases included "felt like touching an actual person," "felt like a natural response," and "my actions and partner's actions were related."

## 6. Conclusion

Mobile smart devices with built-in cameras are transforming how we record, edit, and share visual memories. However, as noted above, our way of experiencing photographs has remained mostly unchanged since the nineteenth century, being limited to "seeing." To provide people with the experience of interacting with the figure in the picture, we developed the *I-Portrait* system, which has been described in detail in this paper. Our evaluation results show that the *I-Portrait* system achieves statistically significantly higher scores of social presence and also overall satisfaction compared to traditional portrait photographs. It significantly increased the level of mutual awareness, emotional connectedness, and awareness of co-location with individuals who are physically distant. Particularly emotional connectedness was more strongly affected than others. These findings are similar to those of studies indicating that interactivity is correlated with social presence



(Fortin & Dholakiab, 2005) and that social presence enhances satisfaction (Richardson & Swan, 2003).

With the advent of online social networks, people often share and exchange their grief and empathy by sharing photos and memories of bereaved people on the social networks (Döveling, 2015; Giaxoglou, Döveling, & Pitsillides, 2017). I-Portraits may be used as a new tool to help people who have experienced bereavement or separation to gradually overcome the grief of loss by providing the experience that seems to interact or have a conversation with the lost ones anytime they want as well as sharing it with others.

This study has several limitations. First, we did not quantitatively investigate how each of the interactions in the *I-Portrait* affects social presence. Also, we did not investigate the effects of age, sex, country, and subject. More specifically, further research on the effects of the age is needed because the subjects in their 20s generally have a higher preference for the use of the interactive system compared to the older age groups. Lastly, we did not investigate the efficacy of this system in alleviating the grief of loss, which is a future research topic. Another future research direction may include using digital actor technologies along with machine learning technologies to learn the figure's facial expressions and generate reactions of the subject upon users' interactions rather than completely relying on recorded video.

## References

- Barthel, R., Kröner, A., & Hauptert, J. (2013). Mobile interactions with digital object memories. *Pervasive and Mobile Computing*, 9(2), 281–294. doi:10.1016/j.pmcj.2012.05.005
- Beldad, A. D., & Hegner, S. M. (2017). More photos from me to thee: Factors influencing the intention to continue sharing personal photos on an online social networking (OSN) site among young adults in the Netherlands. *International Journal of Human-Computer Interaction*, 33(5), 410–422. doi:10.1080/10447318.2016.1254890
- Biocca, F., Harms, C., & Burgoon, J. K. (2003). Toward a more robust theory and measure of social presence: Review and suggested criteria. *Presence: Teleoperators and Virtual Environments*, 12(5), 456–480. doi:10.1162/105474603322761270
- Brave, S., & Nass, C. (2003). Emotion in human-computer interaction. In A. Sears, J. A. Jacko (Eds.), *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications*, (pp. 53–68). Boca Raton: CRC Press.
- Chung, H., & Zhao, X. (2004). Effects of perceived interactivity on web site preference and memory: Role of personal motivation. *Journal of Computer-Mediated Communication*, 10(1), JCMC1017.
- Counts, S., & Fellheimer, E. (2004, April). Supporting social presence through lightweight photo sharing on and off the desktop. In E. Dykstra-Erickson & M. Tscheligi (Eds.), *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 599–606). New York, NY: ACM.
- Crawford, C. (2002). *The art of interactive design: A euphonious and illuminating guide to building successful software*. San Francisco, CA: No Starch Press.
- Davis, A., Chen, J. G., & Durand, F. (2015). Image-space modal bases for plausible manipulation of objects in video. *ACM Transactions on Graphics (TOG)*, 34(6), 239. doi:10.1145/2816795.2818095
- Döveling, K. (2015). Emotion regulation in bereavement: Searching for and finding emotional support in social network sites. *New Review of Hypermedia and Multimedia*, 21(1–2), 106–122. doi:10.1080/13614568.2014.983558
- Ekman, P. (1993). Facial expression and emotion. *American Psychologist*, 48(4), 384. doi:10.1037/0003-066X.48.4.384
- England, E., & Finney, A. (2011). Interactive media—What's that? Who's involved? Retrieved from [http://www.atsf.co.uk/atsf/interactive\\_media.pdf](http://www.atsf.co.uk/atsf/interactive_media.pdf)
- Fogg, B. J. (2002). Persuasive technology: Using computers to change what we think and do. *Ubiquity*, 2002, 89–120. doi:10.1145/764008.763957
- Fortin, D. R., & Dholakiab, R. R. (2005). Interactivity and vividness effects on social presence and involvement with a web-based advertisement. *Journal of Business Research*, 58, 387–396. doi:10.1016/S0148-2963(03)00106-1
- Friedman, H. S., & Riggio, R. E. (1981). Effect of individual differences in nonverbal expressiveness on transmission of emotion. *Journal of Nonverbal Behavior*, 6(2), 96–104. doi:10.1007/BF00987285
- Giaxoglou, K., Döveling, K., & Pitsillides, S. (2017). Networked emotions: Interdisciplinary perspectives on sharing loss online. *Journal of Broadcasting & Electronic Media*, 61, 1–10. doi:10.1080/08838151.2016.1273927
- Gooch, D., & Watts, L. (2015). The impact of social presence on feelings of closeness in personal relationships. *Interacting with Computers*, 27(6), 661–674. doi:10.1093/iwc/iwu020
- Guéguen, N., & Jacob, C. (2002). Social presence reinforcement and computer-mediated communication: The effect of the solicitor's photograph on compliance to a survey request made by e-mail. *CyberPsychology & Behavior*, 5(2), 139–142. doi:10.1089/109493102753770525
- Gye, L. (2007). Picture this: The impact of mobile camera phones on personal photographic practices. *Continuum*, 21(2), 279–288. doi:10.1080/10304310701269107
- Hertenstein, M. J., Keltner, D., App, B., Bulleit, B. A., & Jaskolka, A. R. (2006). Touch communicates distinct emotions. *Emotion*, 6(3), 528. doi:10.1037/1528-3542.6.3.528
- Hornbæk, K., & Oulasvirta, A. (2017). What is interaction? In G. Mark, S. Fussell, C. Lampe, M. C. Schraefel, J. P. Hourcade, C. Appert, & D. Wigdor (Eds.), *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 5040–5052). New York, NY: ACM.
- Hunt, D. S., Lin, C. A., & Atkin, D. J. (2014). Communicating social relationships via the use of photo-messaging. *Journal of Broadcasting & Electronic Media*, 58(2), 234–252. doi:10.1080/08838151.2014.906430
- Hwang, H. S. (2007). Development of social presence measurement of mediated social interaction: A case study of instant messaging. *Journal of Communication Science*, 7(2), 529561.
- Hwang, H. S., & Lombard, M. (2006). Understanding instant messaging: Gratifications and social presence. In C. C. Bracken & M. Lombard (Eds.), *Proceedings of PRESENCE 2006* (pp. 50–56). Cleveland, OH: International Society for Presence Research.
- Hwang, H. S., & Park, S. (2007). Being together: User's subjective experience of social presence in CMC environments. In J. A. Jacko (Ed.), *Human-Computer Interaction. Interaction Design and Usability. HCI 2007, Beijing, China. Lecture Notes in Computer Science* (Vol. 4550, pp. 844–853). Springer, Berlin, Heidelberg.
- IJsselstein, W., van Baren, J., & van Lanen, F. (2003). Staying in touch: Social presence and connectedness through synchronous and asynchronous communication media. *Human-Computer Interaction: Theory and Practice (Part II)*, 2(924), e928.
- Ji, H. S. (2016). Exploring the usage of pictures on smartphone. In G. Lee, M.-Y. Choi, J.-Y. Heo, S. Jeon, N. C. Park, & H. Jung (Eds.), *Conference on the HCI Society of Korea* (pp. 561–566). New York, NY: ACM.
- Jin, Y., Choi, S., Chung, A., Myung, I., Lee, J., Kim, M., & Woo, J. (2004). GIA: Design of a gesture-based interaction photo album. *Personal and Ubiquitous Computing*, 8(3–4), 227–233. doi:10.1007/s00779-004-0282-y
- Kawamura, T., Fukuhara, T., Takeda, H., Kono, Y., & Kidode, M. (2007). Ubiquitous Memories: A memory externalization system using physical objects. *Personal and Ubiquitous Computing*, 11(4), 287–298. doi:10.1007/s00779-006-0085-4
- Kindberg, T., Spasojevic, M., Fleck, R., & Sellen, A. (2005). I saw this and thought of you: Some social uses of camera phones. In G. van der



- Veer & C. Gale (Eds.), *CHI'05 extended abstracts on human factors in computing systems* (pp. 1545–1548). New York, NY: ACM.
- Lombard, M., & Ditton, T. (1997). At the heart of it all: The concept of presence. *Journal of Computer-Mediated Communication*, 3(2), JCMC321.
- Lopes, D. M. M. (2001). The ontology of interactive art. *Journal of Aesthetic Education*, 35(4), 65–81. doi:10.2307/3333787
- Markus, M. L. (1990). Theory of interactive media. In J. Fulk & C. Steinfield (Eds.), *Organizations and communication technology* (pp. 194–218). Thousand Oaks: Sage.
- Mynatt, E. D., Rowan, J., Craighill, S., & Jacobs, A. (2001). Digital family portraits: Supporting peace of mind for extended family members. In J. Jacko & A. Sears (Eds.), *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 333–340). New York, NY: ACM.
- Nowak, K. L., & Biocca, F. (2003). The effect of the agency and anthropomorphism on users' sense of telepresence, copresence, and social presence in virtual environments. *Presence: Teleoperators and Virtual Environments*, 12(5), 481–494. doi:10.1162/105474603322761289
- Peters, L. (1998). The new interactive media: One-to-one, but who to whom? *Marketing Intelligence & Planning*, 16(1), 22–30. doi:10.1108/02634509810199472
- Rettie, R. (2003). Connectedness, awareness and social presence. In *Proceedings of PRESENCE 2003*, Aalborg, Denmark. doi:10.1.1.101.9820
- Richardson, J., & Swan, K. (2003). Examining social presence in online courses in relation to students' perceived learning and satisfaction. *Journal of Asynchronous Learning Networks*, 7, 68–88.
- Riva, G., & Mantovani, F. (2014). Extending the self through the tools and the others: A general framework for presence and social presence in mediated interactions. In G. Riva, J. Waterworth, & D. Murray (Eds.), *Interacting with Presence: HCI and the Sense of Presence in Computer-Mediated Environments* (pp. 9–31). De Gruyter Open Ltd. doi: 10.2478/9783110409697.1
- Rivière, C. (2005). Mobile camera phones: A new form of “being together” in daily interpersonal communication. In R. Ling & P. E. Pedersen (Eds.), *Mobile communications* (pp. 167–185). London: Springer.
- Romero, N., Markopoulos, P., Baren, J., Ruyter, B., Ijsselstein, W., & Farshchian, B. (2007). Connecting the family with awareness systems. *Personal and Ubiquitous Computing*, 11(4), 299–312. doi:10.1007/s00779-006-0089-0
- Santella, A., Agrawala, M., DeCarlo, D., Salesin, D., & Cohen, M. (2006). Gaze-based interaction for semi-automatic photo cropping. In R. Grinter, T. Rodden, P. Aoki, E. Cutrell, R. Jeffries, & G. Olson (Eds.), *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 771–780). New York, NY: ACM.
- Scherer, K. R. (1995). Expression of emotion in voice and music. *Journal of Voice*, 9(3), 235–248.
- Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications*. New York, NY: Wiley.
- So, H. J., & Brush, T. A. (2008). Student perceptions of collaborative learning, social presence and satisfaction in a blended learning environment: Relationships and critical factors. *Computers & Education*, 51(1), 318–336. doi:10.1016/j.compedu.2007.05.009
- Steuer, J. (1992). Defining virtual reality: Dimensions determining telepresence. *Journal of Communication*, 42(4), 73–93. doi:10.1111/jcom.1992.42.issue-4
- Teo, H. H., Oh, L. B., Liu, C., & Wei, K. K. (2003). An empirical study of the effects of interactivity on web user attitude. *International Journal of Human-Computer Studies*, 58(3), 281–305. doi:10.1016/S1071-5819(03)00008-9
- Towell, J., & Towell, E. (1997). Presence in text-based networked virtual environments or “MUDS.”. *Presence: Teleoperators and Virtual Environments*, 6(5), 590–595. doi:10.1162/pres.1997.6.5.590
- Tu, C. H., & McIsaac, M. (2002). The relationship of social presence and interaction in online classes. *American Journal of Distance Education*, 16(3), 131–150. doi:10.1207/S15389286AJDE1603\_2
- Van Dijck, J. (2007). *Mediated memories in the digital age*. Palo Alto, CA: Stanford University Press.
- Van Dijck, J. (2008). Digital photograph: Communication, identity, memory. *Visual Communication*, 7(1), 57–76. doi:10.1177/1470357207084865
- Van House, N., Davis, M., Ames, M., Finn, M., & Viswanathan, V. (2005). The uses of personal networked digital imaging: An empirical study of cameraphone photos and sharing. In G. van der Veer & C. Gale (Eds.), *CHI'05 Extended Abstracts on Human factors in computing systems* (pp. 1853–1856). New York, NY: ACM.
- Van House, N. (2009). Collocated photo sharing, story-telling, and the performance of self. *International Journal of Human-Computer Studies*, 67(12), 1073–1086. doi:10.1016/j.ijhcs.2009.09.003
- Yoo, Y., & Alavi, M. (2001). Media and group cohesion: Relative influences on social presence, task participation, and group consensus. *MIS Quarterly*, 25(3), 371–390. doi:10.2307/3250922
- Zheng, J., Veinott, E., Bos, N., Olson, J. S., & Olson, G. M. (2002). Trust without touch: Jumpstarting long-distance trust with initial social activities. In D. Wixon (Ed.), *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 141–146). New York, NY: ACM. doi:10.1044/1059-0889(2002/er01)

## About the Authors

**Seungwan Ha** is a human-centered computing researcher. He holds a M.A.S. in Art & Technology from Sogang University and a B.F.A. in Photography from Chung-Ang University. His research interests include human-computer interaction, human-robot interaction, and social media technologies.

**Jusub Kim** is an associate professor of department of Art & Technology at Sogang University. His research interests include creative technologies, human-computer interaction, and new media. He holds a Ph.D. in electrical & computer engineering from University of Maryland at College Park.