



# Flower-Pop: Facilitating Casual Group Conversations With Multiple Mobile Devices

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We explore the potential use of mobile devices as a collaborative sensing system that can proactively mediate casual group conversations. In this study, we aim to investigate (i) the impacts of a mobile system's passive and active conversation facilitation and (ii) the ways in which sociocultural aspects that affect casual group conversation should be considered in the design of proactive mobile systems. Toward this goal, we developed Flower-Pop, a mobile system that monitors group conversations and visualizes interaction patterns using metaphorical expressions based on blossoms. This system provides passive facilitation as well as active facilitation modes such as proactive conversation visualization and photo sharing. The active modes can encourage inactive participants to share photos and select random people to speak. Focusing on Korea, our field study showed that Flower-Pop's mediation created smooth topic/speaker transitions and encouraged less-active speakers to better engage in group conversation. We also found that the sociocultural aspects of casual group conversation, such as the location's characteristics, social relations, and the group's interests, affected participants' use of the Flower-Pop system. Based on our findings, we discuss methods for designing mobile systems for conversation facilitation and outline how opportune sociocultural factors could be identified based on mobile devices.

CCS Concepts: • **Human-centered computing** → *Empirical studies in HCI*;

## KEYWORDS

Mobile devices; collocated social interaction; group conversation.

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## 1 INTRODUCTION

When building relationships in a group, casual group conversation is important. During such casual conversations, group members disclose personal information, which causes feelings of intimacy among the group members to increase [12,18]. However, the ability to successfully and strategically self-disclose in a casual conversation is a personal competency that many people do not possess. In general, it is difficult to engage everyone equally in a group in conversation. In a group

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conversation, each person takes part, but it is not uncommon for a few people to dominate a group conversation while the rest mostly remain silent and do not provide questions or comments. Other difficulties are related to the group members' sociocultural backgrounds. People from different cultures have distinct cognitive patterns and social orientations [9,21]. These can affect how members ask questions, seek information, and socialize during a group conversation. Accordingly, due to the various possible combinations of participants, including diverse characteristics and sociocultural backgrounds, it is difficult but necessary to tailor conversation patterns and topics to one's conversation partners.

Especially in East Asian cultures, participants in casual group conversation seem to take into account a variety of social and cultural factors. These cultures are associated with a holistic, high-context cognitive pattern and with an interdependent and collectivist social orientation [39,46,47]. One of the distinctive characteristics of these cultures' group conversations is that they attend to relationships first—before the subject matter—by, for instance, using honorifics to indicate modesty and respect for others [2]. Regarding subject matter, talking about politics, religion, or sex with new acquaintances can be socially awkward [33,34,48].

Researchers in the HCI community have noticed the potential value that technology-mediated solutions using mobile devices can have in group-conversation contexts [20,31,32,37,41]. However, most previous explorations of mobile systems to support group conversation have been in the context of decision-making and work environments, not casual group conversation. Thus, the sociocultural aspects of using such systems in casual, everyday situations have not been fully explored. Moreover, the use of mobile devices has been limited to either *channels for content sharing* or *communication monitors*. In both approaches, mobile systems have mainly been used to support users' existing behaviors and reflections. In other words, mobile systems have not been developed to recognize the diverse characteristics of group conversation or to actively intervene in such a conversation.

A skilled human facilitator can sometimes trigger spontaneous social interactions among group members and support natural self-disclosures that warm up a conversation, whether it is in a meeting, training class, team-building session, or another event. This has inspired us to explore the potential use of mobile devices to facilitate casual group conversations. In this paper, we do not aim to present a perfect mobile system. Rather, our aim is to learn about the potential role that mobile systems can play in casual group conversations. In exploring this role, we particularly aim to investigate (i) the impacts of a mobile system's passive and active conversation facilitation and (ii) the ways in which the sociocultural aspects that affect casual group conversations should be considered in the design of adaptive and proactive mobile systems.

For this research, we designed and developed Flower-Pop, a mobile system that supports casual, face-to-face group conversations. Flower-Pop consists of multiple mobile devices, a table, and a short-throw projector; it uses a custom-built software platform. This system provides facilitation modes that use visualization and photo sharing to both passively and actively interact in group conversations. This system provides passive facilitation modes such as a channel for content sharing and a communication monitor; its active facilitation modes include proactive conversation visualization and photo sharing to encourage inactive participants to share photos and select random people to speak. We evaluated the design and its impacts in a field study regarding the potential use of mobile devices as tools to facilitate group conversation. Based on interviews with study participants, we further discuss how to improve mobile systems so that they fit naturally in the casual conversation context. By understanding the potential sociocultural advantages and challenges of using such systems in casual group conversations, we will be able to develop a mobile system that smoothly supports and moderates conversations. Through this research, we hope to gain insight about how to design mobile systems that act as conversation facilitators to support interpersonal relationship development in a casual conversation context and about how to develop HCI technologies for this specific context.

## 2 RELATED WORK

Technologies for casual group conversation have been investigated for a variety of purposes, from allowing individuals to reshape their experiences of time and space [8] to helping them to adapt their social perspectives [17,24,43]. According to the previous studies, in casual settings, shared communication technologies (e.g., television and radio) are often welcomed [25], but personal devices are viewed as creating tension among group members; the use of such devices is often managed through various social norms and restrictions [15,16]. These findings mean there is a need for future work to explore the ways in which technologies can be meaningfully integrated into the social space of group conversations and thereby contribute to social interactions. In the same vein, our research project explores the ways in which mobile systems can be

used in everyday conversational situations. In the following section, we present technology-mediated solutions that have been used in casual group conversations and review the sociocultural characteristics of such conversations.

## 2.1 Technology-mediated Solutions in Casual Group Conversation

Researchers in the HCI community have noticed the potential value of technology-mediated solutions in which mobile devices are used in group conversations[14]. In terms of functionality, significant developments have supported various group-conversation activities. The HCI literature contains many use cases for collocated mobile devices, including conversation visualization [13,28,29,42], media sharing [16,38,41], and collocated searching tasks; these use cases often involve interaction with additional screens or multiple mobile devices [32]. These works demonstrate the benefits of using technology in collocated interactions and refute the negative view that mobile devices create social isolation.

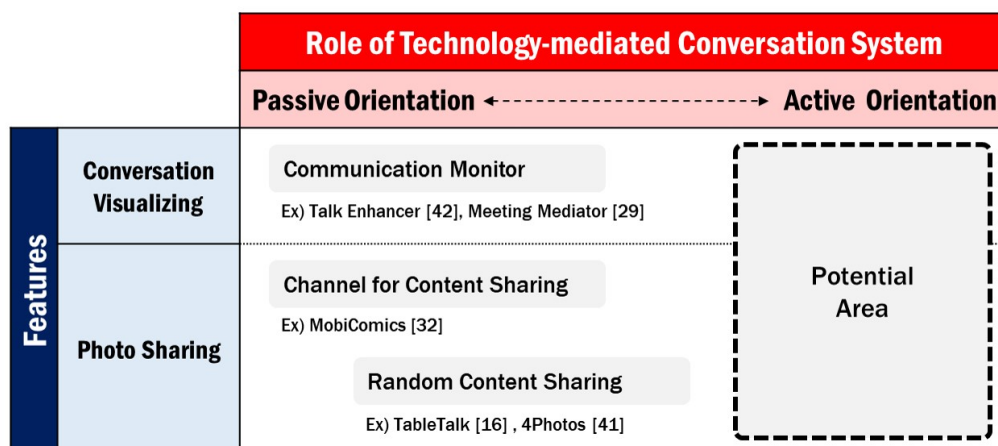


Fig. 1. Examples of Technology-mediated Conversation-Supporting Systems

However, in terms of passive–active orientation, technologies such as mobile devices have been studied to only a limited degree. In a group conversation with a passive–active orientation, social interactions among group members can be active and spontaneous or passive and reluctant. From this perspective, the design space regarding technology-mediated solutions (including conversation visualization and photo sharing) can be explored further (Figure 1).

One significant area of investigation concerns how systems affect face-to-face communication by visualizing a group’s communication patterns [13,29,42]. For instance, DiMicco et al. created a shared group display for small groups [13]. Their system displays speakers’ participation ratios on a bar chart that is projected onto a wall. Through this visualization, over-participating and under-participating speakers are encouraged to balance their participation levels. Some studies show subtle nuances within group dynamics when providing implicit representation [6,20,28]. Karahalios and Bergstrom proposed a system called Conversation Clock for visualizing conversations among people sitting around a table [6]. In Conversation Clock, microphones placed on a table capture individual audio streams, and the system visualizes all of the streams by projecting them onto the tabletop in real time. The system recognizes the utterances and visualizes the conversation patterns. These works have demonstrated that visualizing participation levels in real time tends to close the gap between over-participating and under-participating group members by encouraging individuals to censor or otherwise alter the nature of their communications. Still, these systems are limited to *passive conversation monitoring* that makes the participants aware of their conversation patterns.

Several prior studies have used short-range communication technologies to investigate situations in which collocated users engage in collaborative activities using mobile devices, thus transitioning personal, individual experiences to shared multiuser experiences [26,32,40]. Mobile systems commonly include photo sharing, which can be used during casual group conversations. For example, these systems provide easy ways to duplicate images, start automatic slideshows, and tile devices together to create larger joint displays. These kinds of mobile device-enabled activities support rich social interactions by enabling discussions about photos during face-to-face conversations. For instance, TableTalk integrates

personal devices into a shared display to enrich meal-based social interactions by showing personal content [16]. 4Photos is designed as a dining-table centerpiece that collates photos during mealtime and displays them for all participants to interact with [41]. The authors found that content sharing stimulates reminiscence, bonding, education, and socialization. However, in the case of the photo sharing feature, the mobile system remains a *channel for content sharing*, displaying either participant-selected or randomly chosen photos (Figure 1). The active mode in which the system judges photos and suggests suitable ones has not been explored.

In terms of passive–active orientation, in past works, mobile devices have been limited to passive roles in group conversations, as either (i) content-sharing channels or (ii) communication monitors. For both these approaches, mobile systems have mainly been used to support users’ behaviors and reflections. In other words, mobile systems have not been developed to recognize the diverse aspects of group conversations or to actively intervene in such conversations. Our approach is similar in scope to the ones described above, but we aim to explore the design of mobile systems to facilitate—and even actively influence—group conversations rather than just passively visualize the individual contributions in a structured task.

Rather than relying only on making individuals more aware of their own behaviors and on supporting their additional activities, we designed our Flower-Pop system to investigate the passive and active roles in a mobile system that supports group behavior by monitoring conversation patterns. An active conversation facilitator is useful for quickly building relationships, as it encourages speakers to participate in group activities and to self-disclose [12,18,26]. In this respect, there has been insufficient investigation of either mobile devices’ uses in facilitating group conversations and or the embedding of such devices in a casual conversation context. Thus, in this research project, we explore the role that mobile systems play in group conversations, including as active conversation facilitators that invite conversation participants to interact socially and provide self-disclosure. The mobile system’s intelligence is expected to develop progressively, so our study will provide knowledge regarding the design of mobile systems that are adaptive and appropriately responsive to casual group conversations.

Below, we investigate the sociocultural aspects of casual group conversation and use these aspects to design a mobile system that acts as a conversation facilitator.

## 2.2 Sociocultural Aspects in Casual Group Conversation

People from different cultures present distinct cognitive patterns and social orientations [9,21], which can affect how they ask questions, seek information, and socialize during a group conversations. Thus, it is important to understand the role of sociocultural factors when designing technological mechanisms to support casual group conversation. Our aim with this research is to learn about the potential role of mobile systems in casual group conversations and especially as conversation facilitators. It is necessary to understand the social and cultural factors that people take into account in group conversations. By understanding the potential sociocultural advantages and challenges of casual group conversations, it will be possible to develop a mobile system that smoothly supports and moderates conversations.

In general, Western cultures are associated with an analytic, low-context cognitive pattern and with an individualist social orientation; by contrast, Eastern cultures are associated with a holistic, high-context cognitive pattern and with an interdependent and collectivist social orientation [39,46,47]. These differences are prominent in the group conversation pattern. Group conversations in Eastern cultures take into account a variety of social and cultural factors. Especially, one of the distinctive characteristics of group conversations in East Asian cultures is that participants attend to relationships before subject matter, using honorifics to indicate modesty and respect for others [2]. Among East Asian speakers, group conversations can spring from traditional values of propriety and deference. Propriety refers to respect for a hierarchical order in human relationships. Deference involves yielding to differing or opposing views. A group member who practices propriety and deference is passive and defensive in group conversations. In addition, East Asian speakers seek harmony in group conversations. In most aspects of interpersonal communication within these cultural areas, participants must take into account the other people’s feelings and speak to avoid hurting those feelings. Most East Asian societies value avoiding confrontation and maintaining harmony. High context is another aspect of the East Asian style of group conversation, which is more affective and situation-oriented than the Western style. Nonlinguistic elements such as feelings and attitudes play an important role in interpersonal communication in the Eastern style. The Western instrumental style emphasizes ideas and thoughts, but the more affective East Asian communication style emphasizes feelings [45].

Some of the research on communication systems has implied the importance of sociocultural and environmental factors. For instance, research on technology use in the home and in public settings has shown that social relations among group members affect technology use. Hiniker et al. showed that specific social relationships (e.g., parent-child relationships) cause some of the differences in technology use, which implies that systems should be designed with groups' sociocultural backgrounds in mind [19]. In the same vein, O'Hara et al. showed that people care about host-guest and adult-child relationships when using technological supports during mealtime [41]. Because the previous research implies that sociocultural factors are important, it is necessary to explore specific sociocultural aspects of casual group conversations and to develop a system that is aware of such aspects to ensure smooth conversation facilitation. This study does not aim to compare cultures. However, to develop a system that is more adaptable to casual conversation situations, we aim to explore the factors that people care about in conversation (beyond simple conversational utterances). In particular, we aim to learn about the advantages and challenges of using mobile devices as active facilitators in a culture that places particular emphasis on having both hierarchy and high context in group conversations.

### 3 DESIGN OF FLOWER-POP

We present Flower-Pop, a mobile system that supports group conversations in collocated situations by monitoring real-time communication and by moderating photo sharing based on communication tendencies. Similar mobile-system functions have already been investigated, but our work aims to take the research a step further by exploring the possibility of using mobile systems as active facilitators in casual group conversations. Thus, we use Flower-Pop to gain basic knowledge for the designing of mobile systems that are adaptive and appropriately responsive in a casual group-conversation context. Throughout the ideation and design processes, we devised modes of conversation visualization and photo sharing to cover both passive and active interaction orientations.

#### 3.1 Ideation Process

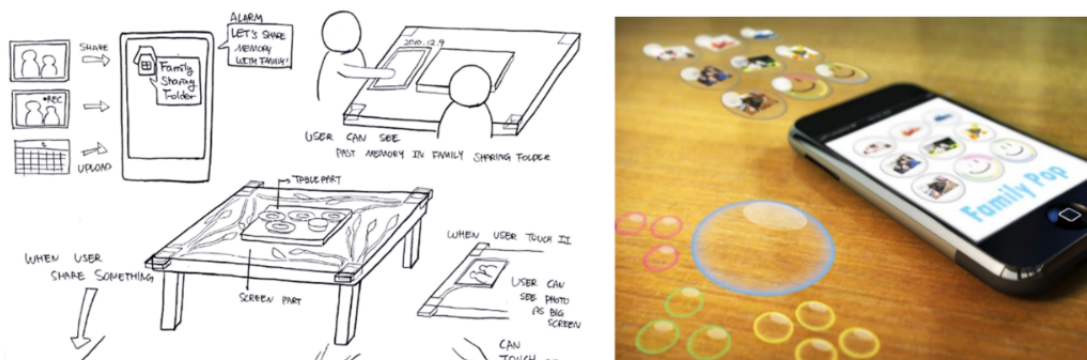


Fig. 2. Sketch of Flower-Pop

The design of Flower-Pop started with an ideation session that focused on ways to help groups have lively conversations. By considering situations such as meals and tea meeting, when casual group conversations take place, we tried to design a system that would be suitable for a space where groups sit around a table, such as a coffee shop or a dining room. Another important ideation criterion was the utilization of devices that are likely to be found in everyday environments.

As a result, we devised the initial idea for Flower-Pop, a system through which group members can use their mobile devices to identify the conversation's progress and to share conversation materials (Figure 2). We imagined that a group of family members or friends would sit around a table and make conversation according to the guidance of the mobile devices. The main feature of the initial Flower-Pop idea was that it informed conversation patterns through visual expressions. The conversation patterns were to be visualized on the table using a projector. The second feature was that it allowed group members to share conversation materials such as photos and videos. The third feature was that it automatically suggested conversation topics.

### 3.2 Flower-Pop's System Configuration and Architecture

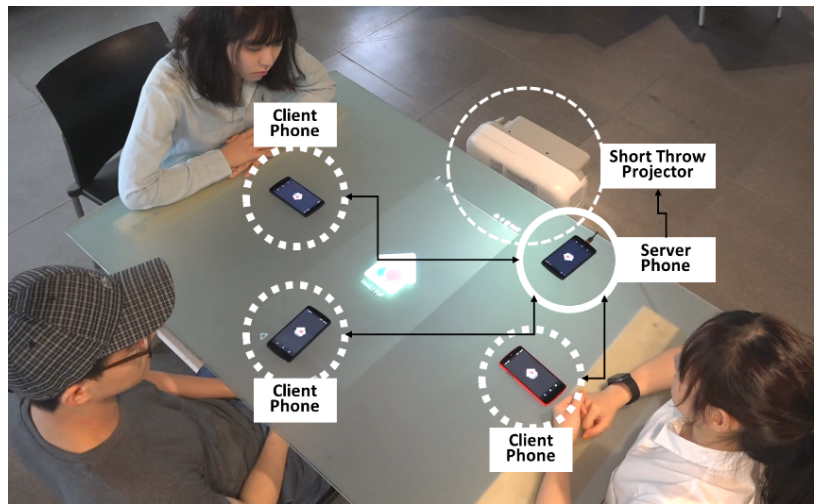


Fig. 3. System Configuration

Based on the idea of using mobile devices in group conversations, we developed the basic architecture of Flower-Pop. Throughout exploration on the possibility of technical feasibility, we ensured that Flower-Pop would allow conversation participants to sit around a table and use mobile devices (which would be given to each person) during a group conversation. For this reason, we implemented the Flower-Pop system with multiple mobile devices and a shared peripheral display using a projector.

We connected all the mobile devices to a local Wi-Fi network to allow for peer-to-peer communication. The system architecture was based on the client–server model. The server device’s screen was projected onto the table surface using a short-throw projector (Figure 3). The server module visualized shared information on the tabletop display and processed audio data. Because we implemented the entire Flower-Pop system using mobile devices, users could easily set it up anywhere. Another advantage was that the use of mobile phones enabled distributed audio sensing. In other words, the audio signals from each mobile phone could be aggregated on the server device and used to draw inferences about metalinguistic events such as turn-taking and speaker changes or about situational events such as laughter.

When Flower-Pop starts a group session, it calls `startRecord()`, which starts a server thread for distributed audio sensing. The server thread then signals all the connected clients to begin audio sensing. On each client, a thread records the audio stream (using Android’s `MediaRecorder` API) and saves the wave stream data locally. To extract features, we used a 300-ms window, which we empirically set after many rounds of trials. Each client calculates the root mean square (RMS) of the samples in a window and sends the result to the server. Given  $n$  users, at time step  $t$ , the server will have a vector of  $(s_{1,t}, s_{2,t}, \dots, s_{n,t})$ , where  $s_{n,i}$  is client  $i$ ’s RMS value at time step  $t$ . Given this data, we leveraged very simple heuristics to detect turn-taking and laughter events and to identify the speakers. Our intuition was that turn-taking would happen when the ambient noise level or signal variation among users was below a certain threshold. Furthermore, because each user’s phone faces that user, speakers can be easily identified by picking the client with the highest RMS value. We inferred that there was group laughter if the RMS values of all the clients were consistently higher than a certain threshold (assuming that every user laughed). To minimize recognition errors for turn-taking and speaker identification, we aggregated the results from several windows and used majority voting for robust detection. We empirically set these parameters before we actually deployed the system. The Flower-Pop system has a user interface for fine-tuning these parameters and to suggest recommended parameter ranges. In our future work, we will employ advanced machine-learning algorithms to improve the performance of the processes described above.

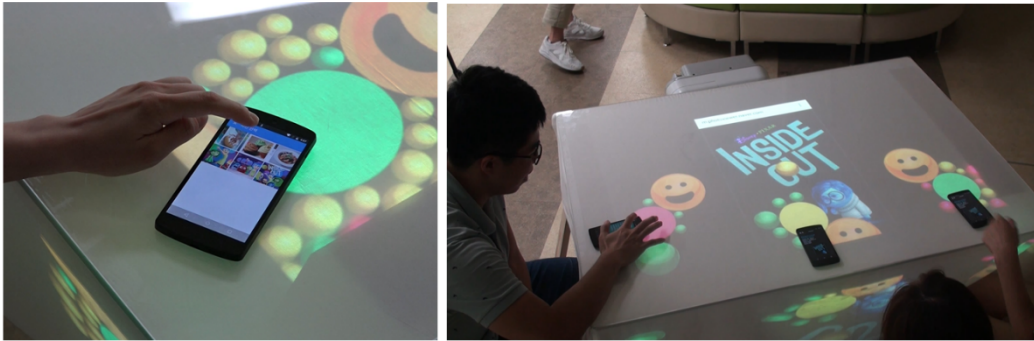


Fig. 4. First Working Flower-Pop Prototype

### 3.3 Flower-Pop Prototype Design and a Pilot Test

Throughout the design process and the pilot test, we progressively improved the visualization types and added subdivided photo-sharing modes by developing and testing the first version of Flower-Pop. The yearlong design and development processes included several rounds of low-fidelity prototype testing and one round of high-fidelity prototype testing (Figure 4). We used the initial Flower-Pop prototype to get inspiration for the design of the visualization style and the facilitation modes, which were to use photo sharing that both passively and actively intervened in the group conversation by considering sociocultural elements. We got feedback from a pilot test using this prototype. In the following section, we describe how we designed the first working prototype and used it in the pilot test.

#### 3.3.1 Features of the Initial System

In our initial Flower-Pop system, the main features included conversation visualization and photo sharing, two features that had been tried previously. As a conversation visualization feature, the system visualized each speaker's utterance data on the tabletop using an image in the shape of a bubble. To visualize who interacted with whom, each participant was designated with a given color when starting a conversation session in the Flower-Pop application. During each conversation session, bubbles were created in front of the speaker, but the color of each bubble followed the color assigned to the previous speaker. The bubble sizes were proportional to the length of the speakers' utterances.

To support content sharing during a conversation session, we designed the system to display on the table the photos that the users selected through their mobile devices. In this version, the Flower-Pop system took a passive role, serving as a channel for content sharing—just as previous conversation-supporting systems had [16,32,41].

In addition, this version included a bomb game. When a participant began this game in the mobile application, the system created a bomb that moved around the table in a random path and then exploded in front of a random participant after a certain period. We implemented this feature to explore whether participants would use such fun but coercive interaction means in a casual conversation situation.

By allowing participants to naturally utilize these features during the conversation, we explored the limitations of the system's visual elements and got feedback about the features' interaction modes.

#### 3.3.2 Pilot Test Results

In the pilot test, we observed how participants used the system during a 30-minute conversation; we also conducted 30-minute interview sessions afterward. Throughout the pilot test, we tried to determine how best to (i) design a mobile system that would be naturally embedded in the sociocultural context of a group conversation and (ii) subdivide and implement the mobile system's features, which included both passive and active orientations.

Two groups of three participants each participated in the pilot test. All participants were interaction designers or HCI researchers who had more than three years of work experience. In the pilot test, we focused on improving the system by listening to the participants' opinions about the prototype. To evaluate the photo sharing feature, before the experiment, we asked each participant to send us 10 photos for the conversation session. Then, we saved those photos on the mobile devices that we prepared for the experiment. During the experiment, each group used a prototype system that allowed

them to conduct 30 minutes of conversation on topics of their choice. We asked the participants to use the conversation-visualization, photo-sharing, and bomb-game features as they wanted.

As a result, we were able to gather the participants' diverse opinions about the Flower-Pop system. First, some commented on the conversation-visualization feature. One of the participants noted that the system's visualization style needed to match the surrounding environment and expressed a preference for an ambient visualization rather than direct diagrammatic feedback [10,11]. Another issue with the conversation visualization was that the bubble-type visualization was too confusing to provide enough information. When the number of utterances increased, causing the bubbles to mix together on the table, the participants found it difficult to know which bubbles were generated by which users.

The participants also mentioned having some difficulties in photo sharing while talking to other conversation participants. In this version, the participants were able to share their pictures on the table on their own, but many noted that it was difficult or uncomfortable to share pictures in this way while talking with the others. Therefore, they said that it would be important to help users display pictures as conversation material at the right time.

In the case of the bomb game, many participants said that it would be difficult to use that game in everyday conversation situations, with a few exceptions. They mentioned that, even when the loser was decided, it was difficult to force that person to talk more actively, which meant that the game was not very helpful to the conversation. To replace the prototype's photo-sharing and bomb-game features, the participants suggested combining photo sharing with gamified characteristics.

### 3.4 Flower-Pop's Final Design

Based on the feedback from the pilot test, we tried to improve the design of the visualization style and the facilitation modes by using photo sharing that both passively and actively interacted with the group conversation. This led to the final Flower-Pop design. For the conversation-visualization feature, we selected blossoms as a visual theme instead of bubbles. Rather than simply visualizing utterances, we devised a visualization of silence that actively encouraged the group to converse (Figure 5). For the photo-sharing feature, we included a manual photo-sharing mode and two modes that would more actively interfere in group conversation sessions: random, forced sharing and encouraged sharing.

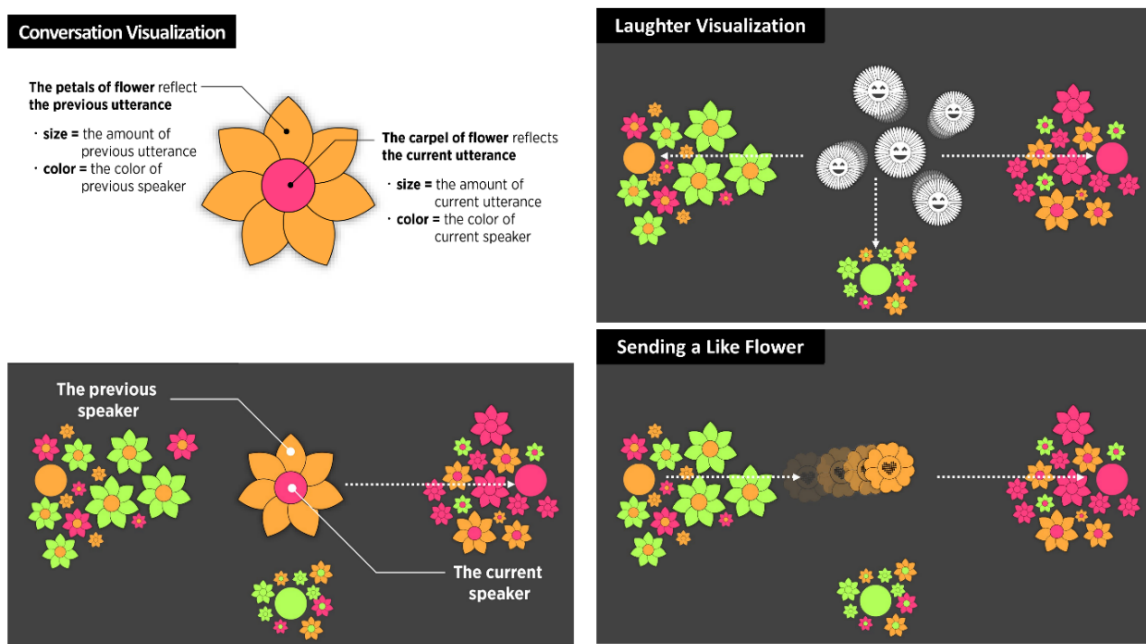


Fig. 5. Visualization of a Casual Group Conversation in Flower-Pop



### 3.4.1 Visual Theme Using Blossoms

Unlike systems used in other research [13], this system focuses on casual group conversations; thus, we designed a visual style that would take social and cultural factors in account. After the iterative design process and the pilot test, we chose to use flowers as the system’s visualization metaphor (Figure 5). There were two reasons for this. First, such a visual expression was suitable to the users’ cultural contexts. We constructed this visual expression based on flowers’ use in Korean culture as a metaphor for animated conversation, as in the proverb “*U-seum-kko-cheul pi-u-da* (a laughter flower has blossomed).” For that reason, a visual expression using flowers was not only well-suited to the users’ cultural backgrounds but also helpful in explaining the purpose of the Flower-Pop system. Second, we adopted the metaphorical expression of flowers mainly because the system is meant to be placed in spaces such as cafes that have everyday conversations. Considering the environmental context of the conversations, the visualization’s use of the flower theme was appropriate; its expressive nature resembled that of a floral tablecloth. Moreover, the visual theme of flowers was appropriate for delivering information to group members in an unobtrusive manner. For similar reasons, previous studies used metaphorical expressions such as flower gardens or forests for persuasive information delivery (e.g., UbiFit Garden [11] or Playful Bottle [10]).

Based on the central function of visualizing dialogue in the shape of a blossom, the system expressed the visual elements of the detailed functions (such as conversation facilitation and photo sharing) according to the structure of a flower. For instance, when group members laugh together, the system creates a flower in the shape of a smile. To encourage the least active member to participate in the conversation, the system utilizes the metaphor of a bee flying among the flowers to represent encouragement. Using the selected visual theme, we harmonized the various features of Flower-Pop into a conversation-supporting tool.

### 3.4.2 Monitoring and Visualizing Group Conversations

		Role of Flower-Pop		
		Passive Orientation	←-----→	Active Orientation
Features	Conversation Visualizing	Supporting User's to Send 'Like' Flower	Creating 'Talk' & 'Laughter' Flowers	Encourage Participation by 'Bee'
	Photo Sharing	Supporting User's Spontaneous Sharing	Supporting Random Photo Sharing	Encouraging Photo Sharing

Potential Area

Fig. 6. Passive–Active Conversation Facilitation

Based on the visual theme, Flower-Pop visualizes the group members’ conversation patterns on the table, acting as a conversation monitor (Figure 6). The system transforms the voices captured on the members’ mobile devices into blossoms that are projected on the table by the short-throw projector underneath it.

When a conversation session starts in the application, a different color is designated for each participant. Using these colors, whenever someone speaks, a series of flowers is rendered on the table around the participants’ mobile devices (Figure 5). Specifically, the color of the flower’s stamen corresponds to the current speaker’s color, and the color of the flower petals corresponds to the previous speaker’s color. This color combination in each flower implicitly visualizes the communicational relationships among the group members. The size of each flower petal is proportional to the length of a participant’s single utterance. As a result, through the combination of flower stamen and petals, each blossom implicitly expresses who has exchanged words with whom.

In addition to the visualization of individual and relational utterances, Flower-Pop shows contextual information when a loud noise is detected on all users’ mobile devices, such as when all members laugh together. In this case, an image of a flower with a smiling icon is sent to all participants.

In addition to simply providing information about the conversational pattern, the system recognizes when a specific group member's participation is remarkably low and actively induces that participant to talk more by showing a bee flying around that participant's position on the table. We designed Flower-Pop, through this mode, to facilitate group conversation more actively—as a conversation facilitator rather than just a conversation monitor.

Unlike the previous visualization modes, in which a mobile system automatically visualized the conversation patterns, Flower-Pop allows group members to intentionally express their reactions. To support sympathetic responses, the system allows users to send a “like” flower with a heart icon to other users by pressing those users' icons on their own mobile devices. The “like” flower is then stored on the table near the target user's position. We wanted to figure out when and how people would use this manual mode to express their feelings during group conversations.

### 3.4.3 Moderating Photo Sharing

Flower-Pop supports group photo sharing in three modes: (i) spontaneous sharing; (ii) random, forced sharing; and (iii) encouraged sharing (Figure 6; Figure 7). These three modes cover various aspects of photo sharing related to controlling a photo's content and the timing with which it is shared. We designed the modes to investigate the passive and active orientations of a mobile system.

In the spontaneous-sharing mode, the mobile system's role is limited to acting as a channel for sharing photos. Users can select 1–4 pictures from the photo galleries on their mobile devices and open those photo(s) whenever they want. This

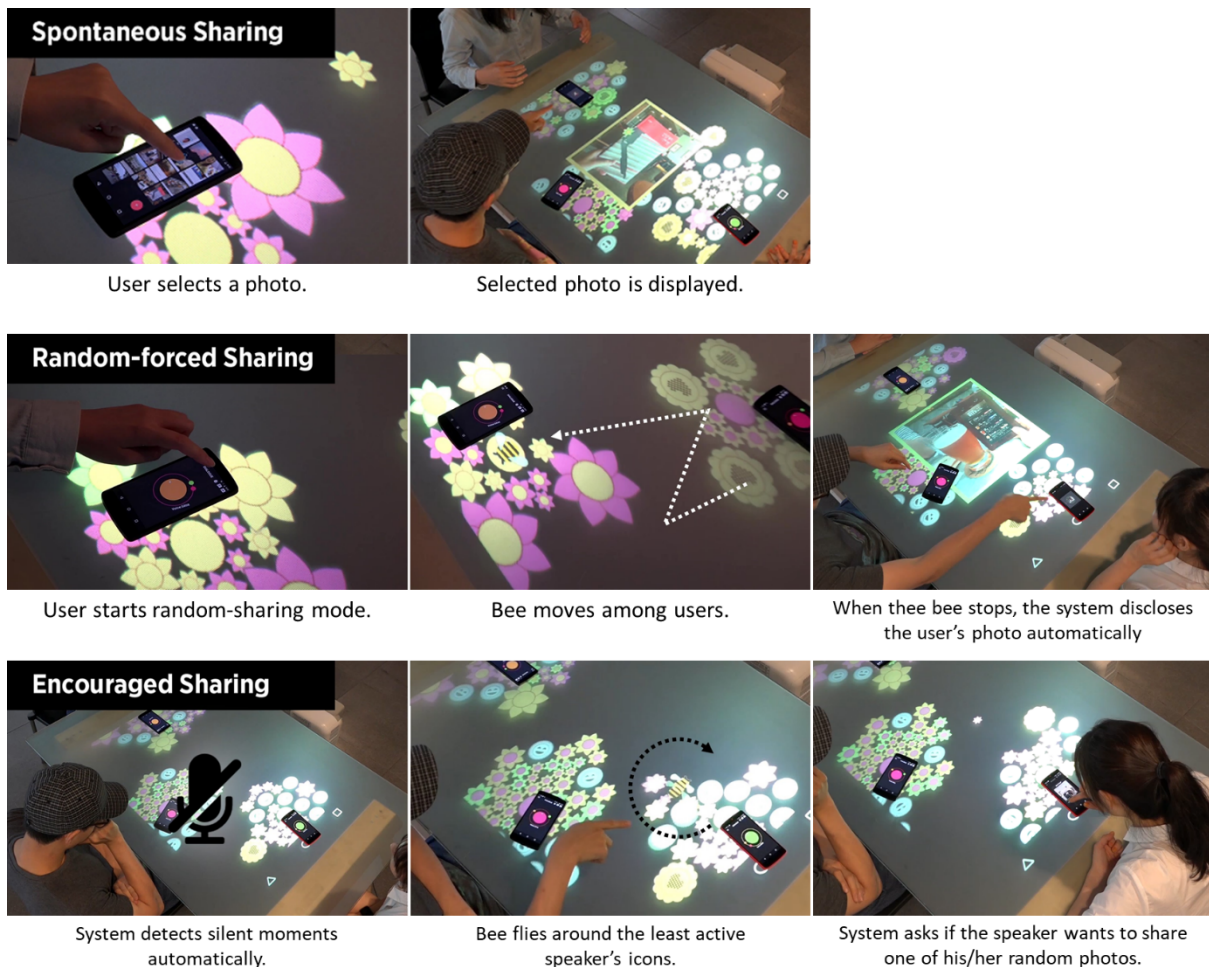


Fig. 7. Flower-Pop's Photo-Sharing Modes

mode of photo sharing has been used in prior studies [32], but Flower-Pop supports other, more active, modes of photo sharing to test the mobile system’s role in group conversations. We designed these other modes of photo sharing based on the results of the pilot test.

The second sharing mode is forced, random sharing, which we designed to reflect the effects of the bomb-game feature from the pilot test. In this mode, if the users press a given button, a bee starts to move among the users at the table. After a random period of time (5–10 seconds), the bee stops at a random user’s location, and the system discloses a random photo from that user automatically. In this case, the user cannot freely determine the type of photo or decide whether it will be shared.

Lastly, Flower-Pop facilitates conversation by monitoring the group members’ communication patterns and by actively prompting photo sharing based its monitoring of the results. Periodically, the Flower-Pop system automatically detects the least active speaker. Although the default period is 1 minute, this setting can be adjusted in the setting menu. After this period elapses, a bee pops up and flies around the least active speaker’s icons. At the same time, on that user’s mobile device, the system asks if that person wants to share a photo to the table at random. If the user selects “Yes,” a random photo from that user is shown on the table. If the speaker selects “No,” the system starts to monitor the communication again. In this encouraged-sharing mode, users can decide when to share, as they can in the spontaneous sharing mode.

## 4 FIELD STUDY

We conducted a field study to examine the ways in which Flower-Pop influences social interaction during a casual group conversation. Using experiments, we aimed to determine how the passive and active roles of the mobile system and its features are utilized in a casual group conversation. We were particularly interested in interactions with and around Flower-Pop, such as the influence of visualization modes on groups’ casual conversations and the influence of facilitation through photo-sharing modes on groups’ casual conversations. Rather than expecting the system to function perfectly, we also tried to investigate the participants’ concerns about Flower-Pop’s passive and active roles, sociocultural aspects that affect casual group conversation, and future needs for the design of mobile systems in regard to casual group conversation.

### 4.1 Participants

Table 1. Participant Group Description

Group Number	Group Description	Duration of Relationship as a Group
Group 1	A group of friends having a common friend (G1-M1 was a friend of G1-M2 and G1-M3, separately)	2 months
Group 2	Newly formed study group members (G2-M1 was a mentor for G2-M2 and G2-M3)	3 months
Group 3	Newly formed study group members (G3-M1 was a senior mentor of G3-M1 and G3-F1)	1 week
Group 4	Newly joined social club members (G4-M1, G4-M2, and G4-M3)	3 months
Group 5	Lab members (G5-M1 and G5-M2), including a newcomer (G5-F1)	2 months
Group 6	Social club members (G6-F1 and G6-F2), including a newcomer (G6-M1)	2 months
Group 7	Lab members (G7-M1 and G7-M2), including a newcomer (G7-F1)	1 week

We deployed the prototype in 7 groups, each of which had 3 persons. The reason for the 3 members of each group is that three types of social relations are formed in the group and it is appropriate to identify the influence of various social relations with the minimum number of persons. To control the dynamics among the groups, each group had to be in the early stage of its social relationship. The average period for which three persons met as a group on a regular basis was 1.80 months ( $SD = 1.12$ ). The groups were required to build a relationship with more than one person. For instance, we recruited groups from social clubs or labs with a newcomer and existing members, from recently established groups for special purposes (i.e., study group), or from new groups of friends who were unfamiliar with each other. The social awkwardness was present, but group members were willing to socialize with each other. We regarded these groups as appropriate for our study since we could observe how Flower-Pop enriches social interactions and self-disclosures as a group facilitator in the context of a casual conversation.

Although the diversity of each group's background was considered, our aim was neither to focus on any particular segment of society nor to obtain a representative sample for generalizability. Nevertheless, we sought diversity of group conversation setting as context for an in-depth examination of group practices with mobile systems as a conversation facilitator.

The groups were recruited through university mailing lists, online bulletin boards, authors' extended social networks, and local community Facebook groups. Eventually, we recruited 7 groups (21 participants, each group consisting of 3 persons) for our study (Table 1). There were 15 male and 6 female participants, with ages ranging from 18 to 32 years ( $M = 22.7$ ,  $SD = 4.09$ ). We paid each group \$50 for participating in the study. Throughout the paper we refer to each participant by a group number (G), sex (M/F), and the week of the interview session (e.g., G2-M1, week 2).

## 4.2 Study Setup

We expected that natural and meaningful uses of Flower-Pop could be better observed in real-life settings than unnatural ones, such as labs [7]. Thus, we conducted the trials in a coffeehouse and a university lounge where a group of people could freely and naturally enjoy face-to-face conversation (Figure 5). A field trial in a coffeehouse was conducted twice for two weeks. By using the system for two weeks, we tried to mitigate transient usage. During our studies, most of the participants agreed that using the device in a public space helped them to elicit truer uses than those conducted in a lab setting.

Before the first week and after the second week session, we conducted a survey about the intimacy among group members using the Inclusion of Other in the Self Scale (pictorial measure of closeness ranging from 1 to 7 points) [4].

Every week, 1–2 days before the scheduled study session, we asked participants to prepare and submit pictures to be used in the group conversation. The topics could include, but were not limited to, their daily lives, Web searching, social issues from SNS, and public news. Participants usually prepared 10 or more screenshots of witty photos and popular topics; in addition, participants provided daily photos that were posted on their SNS or selected from their personal galleries.

During the first week, we conducted a group interview about casual conversations in a coffeehouse and a department lounge for 20 minutes. The questions focused on each group's relationship and the members' backgrounds. We provided the participants with instructions on how to use the system for 10 minutes before the actual usage. Specifically, we described and demonstrated how the conversation would be visualized with diverse blossoms and a bee. Next, they actually started using Flower-Pop for 20 minutes while having a conversation, just as if it were a natural situation in a coffee shop. After the 20-minute usage period, we conducted a 20-minute face-to-face interview with each group to discuss their experiences with Flower-Pop. The questions covered whether the use of Flower-Pop's monitoring and moderating features as a proactive facilitator worked well during casual conversations, in terms of making topics more abundant and the amount of utterances more equally distributed. We also asked about the positive and negative aspects of user experiences and overall usability. In the second week, participants used the system in the same way and were interviewed again. Also, to get insights from the participants about design implications, we asked how the Flower-Pop system could be improved by considering the sociocultural aspects of casual group conversations.



Fig. 8. Deployment of Flower-Pop in a Coffeehouse & a Lounge

### 4.3 Deployment of Devices

Participants were given Android smartphones (Google Nexus 5s) with the Flower-Pop application already installed and photos they had sent to us in advance. The photos were stored on each phone before given to the respective owners. We also asked them to hide their personal mobile phones so that they could perceive the provided devices as their own to support their conversations.

The system, with multiple mobile devices and a project, was installed in a coffee shop and a department lounge (Figure 8). During each conversation, we left the site to prevent any distraction from natural conversation. The conversations were audio and video recorded for later analysis.

### 4.4 Data Analysis

We used an inductive, qualitative analysis approach to the data. All trials and interviews (a total of 10 hours) were audio recorded and transcribed. In particular, we focused on who used Flower-Pop's features, how the features were used, and how the application may support different aspects of group conversation. As indicators of whether the participants were spontaneously involved in the conversation with Flower-Pop, we were concerned with not only voluntary participation and the amount of utterance per person but contextual information within the conversation (e.g., diversity in topics, their transitions, and the flow of a speaker). Further, we were interested in any relationship between individuals or the group; for example, whether group members facilitated turn-taking or whether they encouraged inactive participants to speak.

We analyzed the interview transcripts and video recordings of Flower-Pop usage to add detailed notes regarding all interactions with Flower-Pop and interactions among the group members. These notes were refined through authors' discussions. This analysis was conducted iteratively to identify common themes across groups and unique group practices. After this step, we added one researcher and re-clustered the findings to gain meaningful insights by excluding transient usage. We also tried to identify findings that were more distinct to Flower-Pop in comparison with previous studies.

## 5 FINDINGS

Just as previous studies were conducted with exploratory settings [13,16], our study gained rich insights into the trade-off of using mobile systems. Focusing on the casual group conversation, we aimed to investigate (i) what types of impacts a mobile system's passive and active conversation facilitation would have and (ii) how the participants tried to make the group conversation go smoothly, considering the sociocultural factors to supplement the parts that the Flower-Pop system did not yet solve.

Overall, participants were receptive to the idea of using mobile devices for facilitating a group conversation. Although using a mobile device during a conversation is generally considered to be impolite [19,30,36], participants thought that the system configuration of using personal devices for selecting photos and sharing them on a table was acceptable within the boundaries of social etiquette. While participants talked about the system itself at the beginning of the study, they started to use the system naturally during conversations after becoming accustomed to it. All the participants mentioned that they spent the first day figuring out how to use the Flower-Pop system during group conversations; in the second week, they used the system more naturally and less consciously.

## 5.1 Use of Group Conversation Visualization

The visualized graphics of Flower-Pop had an effect on making a convivial atmosphere more affirmative in a public space. During the study, participants stated that they liked the visualization with blossoms. While they expressed some difficulties construing an overview at a glance, they mentioned that the visualization fits naturally into a casual conversation at a coffee shop: *“I prefer this abstract visualization than diagrams. I think that quantifying too clearly is inhumane”* (G1-M1, week 1). When the research team explained the meaning of the visualized flowers and the cultural background of the visual theme, the participants generally understood the significance and agreed with the visualization methods.



Fig. 9. Group Conversation Visualization (Group 5, week 2)

### 5.1.1 Indirect Supports of Unobtrusive Visualization

We observed that the visualization of members’ interactions indirectly impacted the group’s conversation. The visualization helped participants to identify and refine the flow of the group conversation rather than having a direct impact on it (Figure 9).

For instance, during a conversation, a pair in Group 5 talked to each other about their conversation pattern: *(While looking at visualization on the table) “Would you react to my statement?”* (G5-M1, week 2). *“Since you talk too much, I cannot cut in the conversation”* (G5-M2, week 2). After realizing that M1 was speaking one-sidedly, Group 5 tried to get other members to participate in the conversation. Also, G6-F1 mentioned that *“A lot of flowers with leaves and stamen of the same colors led me to reflect on whether I talk too much”* (G6-F1, week 2). In the case of G6-F1, the fact that she did not collect a variety of colors in the flowers around her position on the table led her to realize that she needed to interact more with others.

Similarly, because the system captures laughter and automatically expresses it as flowers with a smile icon, participants could clearly see how a bond developed between members of the group. G6-F1 mentioned, *“When the laughing flowers were appearing, I felt the confirmation that our conversation was going well”* (Week 2). In this way, the information that was unobtrusively visualized through the system became a basis for recognizing the unnoticed conversation patterns and for confirming the overall mood of the conversation. Although the mobile system did not direct participants on how to lead the conversation, they applied the information to change the way in which they talked.

However, because the system was rendered ambient in the background, sometimes participants did not notice if they focused on conversation and interaction with other group members.

### 5.1.2 Limited Impact of Active Encouragement

In addition to unobtrusively informing the conversation pattern, when a group member's participation level is remarkably low, Flower-Pop recognizes the situation and actively induces the participant to talk by showing the bee around the participant's position on the table. Initially, we anticipated that when a user discovered a bee, he or she would notice the system's instructions and would either try to speak more or share a picture with the group.

However, unlike our expectations, the system's active facilitation and encouragement using bees had a limited effect. There were a few cases in which a participant that the system had pointed at then spontaneously started to talk. When we asked about such situations, the participants answered that one of the reasons for not speaking was that the visualization itself was not coercive or plainly evident like the other visualization modes were. Even if the participants noticed the visualization, they mentioned that it was not enough to rationalize their sudden active utterances: *"I saw the bee around me place, but I hesitated a bit to speak or not. Since other members were speaking, I just neglected the bee"* (G1-M1, week 2). During a study session, we occasionally observed a situation in which the most willing participant pointed out others' flower patterns with bees and led them to recognize it rather than noticing it themselves. *"Oh, the bee appeared! This time, it seems to be your turn to speak"* (G5-M1, week 2). Likewise, with the help of others, the bee interaction could aid in the facilitation of an inactive member's participation.

### 5.1.3 Rare Use of "Like" in Face-To-Face Group Conversation

Moving beyond the functions in which mobile systems automatically visualize conversation patterns and encourage participation, we designed Flower-Pop to support group members in intentionally expressing their feelings, similar to the "Like" feature in Facebook and Instagram. We observed some participants sending a "Like" flower to express appreciation for and interest in shared photos. G7-M2 said that he used the function to emphasize the shared photo and to show that he has had similar thoughts or experiences. During the field study, many participants used it once or twice for curiosity and fun but did not often use it during conversation. In the post-conversation interviews, participants responded that they could fully express empathy using speech, tone, or gesture. In other words, they said that they did not feel the need to express empathy by using the "Like" flower: *"When we talk to each other, I can see if the other person agrees with me or shows interest in his eyes and voice"* (G3-F1, week 2), *"From the audience's point of view, it is natural to nod my head when I agree with the other person. Pressing 'Like' was awkward to the conversation situation"* (G6-M1, week 2). Likewise, we observed that the intentional visualization was redundant in face-to-face conversation, unlike online media where people need it as an empathic expression. There was also a shared opinion that it would be annoying to manually express one's empathy.

## 5.2 Use of Photo-Based Conversation Facilitation

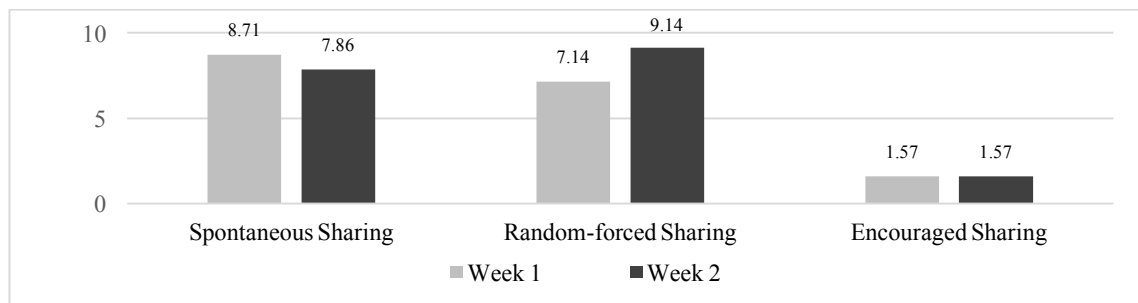


Fig. 10. Average Usage of Photo-Sharing Modes

Participants liked the idea of sharing photos on the table. Most participants agreed that the system helped them to learn detailed information about each other that could not be covered in typical conversations. Participants mentioned that in a group of people at an early relationship-building stage, it would be difficult to explain personal stories by showing personal photos with their mobile devices. However, they said that this system allowed them to disclose diverse personal information, including stories, interests, tastes in food, and opinions on public issues, in a natural manner. Even

participants who are usually passive in group conversations were able to participate in introducing themselves to the other group members.

In general, most photos that participants prepared were related to personal interests, ordinary activities, humor, and public issues. Participants mentioned that the photos were originally from their personal mobile devices and some images were captured from social media (e.g., Facebook account) or public news. During the second week, participants tended to prepare photos that would attract their group's interest, such as photos about activities performed together: *"Last week, I prepared very personal photos including my selfie. But our group could talk much more when I showed the images of bicycling together"* (G1-M3, week 2). Also, they tried to prepare photos that would be easily understandable at a glance, such as photos of foods, and avoided captured images with text, such as news articles.

As shown in Figure 10, each group primarily used spontaneous sharing and random, forced sharing among the three photo-sharing modes. Encouraged sharing occurred about two times in one conversation session but was only used 1.57 times in each session. In addition, five out of seven groups used the random, forced sharing mode more often in the second week than in the first week, while they commonly used spontaneous sharing less often in the second week.

In the following section, the impacts of different facilitating modes on group conversation are explained alongside a description of users' concerns and needs.

### 5.2.1 Expressing Sympathy By Selecting Relevant Photos

Participants used spontaneous photo sharing to relate others' narratives to their own personal experiences. After one of the participants started to talk about his or her photos, group members tried to support the presenter by sharing their own photos. Likewise, participants used spontaneous photo sharing as a way of creating opportunities for more general discussion of related subjects and expressing sympathy. For instance, G2-M1 talked about a humorous image that he had prepared. After G2-M1 explained his taste in humor, G2-M2 opened other humorous images that he had prepared, through which he invited the group into a discussion about this topic, thus allowing others to reveal their own tastes and values. As in the case of Group 1, there were occasions when pictures of sports activities involving other group members were shared during the conversation. As they were enjoying bicycling together regularly, they could share different photos about related topics, which enriched the group conversation. One piece of dialogue started from a photo, and it was finished when the topic had been exhausted.

However, participants mentioned difficulties in spontaneously selecting photos in the middle of conversation. In a casual group conversation, the topics changed frequently and quickly. Unlike the previous research in the context of decision making for one topic, 10-20 topics were covered by each group in our study during 15 to 20-minute conversations. G5-M1 mentioned that it was difficult to catch the right timing for sharing a photo: *"I remembered that I had a relevant photo right after the topic passed quickly. When I noticed it, the right timing was already gone to share one of my photos"* (G5-M1, week 1). As G5-M1 considered the importance of keeping eye contact during conversation, he tried not to look at the mobile device for too long. He mentioned that trying to find interesting and well-matching photos was awkward while focusing on a conversation with others. In addition, even though the participants had found the right timing, some believed that it was embarrassing to bring their own photos because of their passive personalities.

### 5.2.2 Shifting Presenters and Subjects Using Random, Forced Sharing

Participants preferred to share photos in random-forced mode than other photo-sharing modes. For situations in which group members cared too much about their social relationships and proprieties, and therefore conversation was not activated, the random-forced function of Flower-Pop provided an opportunity to broaden the topic of conversation or the range of conversation beyond social relations. This function was frequently used at the beginning of a conversation.

In our study setup, participants rarely knew each other's interests, and they hesitated to bring up a conversation topic. In the case of Group 3, F1 mentioned that selecting appropriate content was particularly difficult because tastes and interests would differ among group members. In addition, because the group norm in regard to who would become a presenter was not yet established, or when there was an age gap and senior-junior relationship, participants tended to take part in the conversation carefully. They mentioned that when talking to each other, they considered the theme and method of conversation, evaluating age, relationship, and so on.

However, participants accepted the inconvenience of breaking etiquette with the Flower-Pop system. In fact, random, forced photo sharing could be used as an icebreaking measure; for example, when the system randomly picked one of the participants and opened a photo, the participant accepted the role and started to explain what the photo was and why he



or she had prepared it. Likewise, the participants used the system as a facilitator to shift and allocate the presenter and listener roles. This function was also useful for changing the subject of conversation.

However, the random-forced sharing mode sometimes interrupted conversation. In the case of Group 3, M1 had prepared an emoticon image of a dancing dog, but it appeared at a moment when the group was discussing their worries about getting fatter. In this example, the randomly selected photo was not relevant to an ongoing or previously discussed topic, which made the situation uncomfortable. G3-M1 mentioned that such sudden topic changes made it difficult for the group to talk deeply about shared topics.

Similarly, because the system automatically discloses photos in mobile devices, participants worried about privacy issues and social face. For instance, even though the individuals sitting near the Flower-Pop table were strangers to our participants, they expressed interest in the shared photos and peeped at the table. In the case of Group 1, M2 had prepared a lewd photo, and it was shared on the table by random-forced mode. Although the photo was acceptable to the group members, he mentioned that it would be important for him to double-check what types of photos would be shown on the table to determine if they were socially acceptable.

### 5.2.3 Managing Conversational Asymmetry By Encouraged Sharing

We designed the system to detect inactive participants. In addition to the visualization for group interactions, the participants used the encouragement to share photos to manage group members' participation. When a bee appeared around an inactive participant, the participant and other group members could catch the moving bee and understand why it appeared with the help of flowers: "Oh, a bee showed up around you!" (G5-M1, week 2), "Did it appear because I was quiet?" (G5-M2, week 2). Then, other members waited until the inactive speaker shared his or her photo and listened to the speaker's explanation of the photo. Some participants appreciated the value of the encouraged photo-sharing function for managing conversational asymmetry: "This system seems like a talk show host leading a group talk by asking questions one by one" (G6-M1, week 2).

In encouraged photo-sharing mode, the system requires users to confirm the sharing of a photo on his or her personal device rather than directly showing a photo on the table. Participants liked the process of confirmation because it helped them to protect their privacy and judge the relevance of a photo. For instance, when the system suggested the sharing of photos, G7-M2 refused to share the selected photo because it seemed outside of other members' mutual interests. Most of the participants said that they accepted sharing photos by considering the relevance between the subject of the suggested photo and the current conversation topic.

While the system supported animated participation in casual group conversation, we observed some resistance to the semi-mandatory and self-disclosure suggestions for inactive speakers. One participant expressed disapproval of the system. G4-M2 was the least active participant, and the system pointed out his inactive participation three consecutive times. Other members asked him to explain his photo, but he mentioned that he felt uncomfortable: "Do we need to rely on the system?" (G4-M2, week 2). This incident demonstrated that an inactive speaker may feel pressured due to frequent requests to share. Although the encouraged sharing mode attracted the group members' attention to inactive participants, the attention could yield negative impacts on certain persons in the long term.

## 5.3 Sociocultural Influences On Casual Group Conversation With Flower-Pop

Considering different combinations of participants with diverse characteristics and sociocultural backgrounds, it is necessary but difficult to tailor conversational patterns and topics to those with whom one is conversing. While participants used the Flower-Pop system, they gained several positive effects but also suffered inconveniences due to Flower-Pop's lack of understanding in terms of sociocultural context. In this section, we explain how the participants tried to evade uncomfortable situations resulting from the system by considering the sociocultural aspects of casual group conversation.

### 5.3.1 Saving Face in a Public Space

One of the most important factors influenced by sociocultural aspects in the conversation was related to saving face. In the current system, visualization and photo sharing were activated on the table, which attracted the attention of unrelated people from the surrounding environment. Participants were keenly aware that a conversation using the system may be too visible in public.

Regarding the visualization, participants mentioned that they did not care much about the exposure of conversation patterns by blossom-shaped visualization. G1-M1 mentioned that because the conversation pattern looked abstract, just like a normal tablecloth, other people may not understand their meanings. However, in the case of photo sharing, participants worried that the Flower-Pop system could select private or rude pictures could and show them to the public: *"I saw that some strangers stared at our table and photos. I prepared some images about vulgar jokes, but they might not be appropriate to be shown in this coffee shop table"* (G1-M2, week 2), *"I hid some lewd pictures that I prepared for my friends. It's okay only with my friends, but I did not want to make an unsightly scene in this coffee shop"* (G1-M1, week 2). All the members of Group 1 said that a mobile system used for a casual group conversation in the public space should be designed to maintain the social faces of group members by monitoring the types of materials that are to be shared.

### 5.3.2 Seeking Proper Photos and Chances of Speaking According to Social Relations

Differences in culture, class, or job position can influence one's usage pattern and user experience with technologies [48]. Through our observation of Group 3 and Group 7, we also glimpsed the probability of impacts from social positions and hierarchical structures. Though both groups were composed of a newcomer and existing members, they showed significantly different behaviors. While a newcomer (G3-M1) who was a senior in Group 3 talked more and used the modes of Flower-Pop most actively, a new member (G7-F1) of Group 7 who was younger than other members showed passive usage and rarely utilized the photo-sharing mode of Flower-Pop. In the survey, G3-M1 (the senior member) reported that intimacy with other group members was enhanced from 2 to 4.5 points; however, the intimacy score of G7-F1 (the junior member of G7) with the others remained at 1 point.

In situations in which a senior-junior relationship was present, senior participants tended to take the initiative in sharing photos and suggesting subject matters more easily, while juniors listened attentively to the senior members and tried to select formal subject matters. By comparison, when all participants were in same age group, like Group 1 and Group 6, they mentioned that it was easier to talk about personal stories and cut off one another's conversation.

### 5.3.3 Being Conscious of Emotional Status and Levels of Attention to Ensure Group Harmony

At the beginning of the experiment, participants hesitated when deciding what type of photos should be shared or what kind of subject would be proper because they could not figure out what would interest other members. In response, they tried to use Flower-Pop's random photo-sharing function. However, as they gradually began to understand each other's interests, they were able to identify the group's common interests and suggest appropriate topics and photos. Likewise, during the study session, participants tried to figure out the attention level and concentration of the other participants. While each participant was able to get a general idea of their participation level through the number and size of flowers, speakers sought to understand the audience's interest and emotional status regarding the topic they were discussing. In other words, speakers tried to find out whether other participants sympathized with or had interest in the material they suggested. Then, they tried to search for ways to raise a new topic for the conversation when the interest of the audience was low: *"I wanted to talk about my trip. However, I changed to another subject because others did not seem interested"* (G1-M1, week 2).

## 6 DISCUSSION

We explored the potential use of mobile devices as a collaborative sensing system that can proactively monitor and mediate casual group conversations beyond passive digital content sharing and displaying. In pursuit of this goal, we developed Flower-Pop, a mobile system that monitors group conversations and visualizes interaction patterns by using a metaphorical expression of blossoms. Group conversation could be mediated with proactive conversation moderation that encouraged inactive persons to share photos or select a random person to speak. Although the current system had a positive impact on the conversation, at the same time, we discovered several challenges for using mobile systems as a conversation facilitator regarding sociocultural aspects of casual group conversation.

While some of our findings reflect what can be found in sociology and psychology literature, no prior work has explored how a mobile system could be designed accordingly to support a casual group conversation. In order to map out the design space for active and adaptable conversation facilitating system, we discuss our findings in the light of what they mean for system design. In particular, we outline how opportune sociocultural factors could be identified based on current mobile devices or soon will be available on mobile devices. Several open challenges regarding how systems could obtain an understanding of how opportune a user's current context is, are pointed out along the way.

## 6.1 How to Utilize Mobile Systems During Casual Group Conversations

We designed the current Flower-Pop system to use mobile devices for supporting a casual group conversation, but the system occasionally dominated the group conversation and led to discomfort. For instance, without considering the place of the conversation, group members' relation and personal interests, the system just forced or put pressure on participants to talk more based on utterance monitoring. G6-M1 and G2-M3 suggested that Flower-Pop not require the quieter people to speak, and explained that giving people space to contribute at the right time for them would result in a much more harmonious dialogue. In our study, there was an incident in which a participant felt uncomfortable about the pressure that the system created. Based on the result, it would be necessary to explore other intervention strategies that would animate active participation of group members who are using a mobile system. However, at the current technical level, it will be difficult for mobile systems to recognize the conversation situation at the same level as a person and to play the role of an active facilitator. Therefore, it is necessary to gradually expand the use of mobile systems to support and assist the participants, rather than allowing such systems to play an independent role. Given the technical situation, we propose an alternative approach to utilizing mobile systems in casual group conversations.

### 6.1.1 *Conversational Game For Providing Structured Interactions*

The first possible approach is to use mobile systems as a conversational game. Since Flower-Pop itself does not form a hierarchical relationship with the participants of the conversation, people did not consider Flower-Pop's random, forced sharing and conversation facilitation to be impolite. Accordingly, it is possible to utilize the mobile system to provide a group with a more controlled but gamified experience during the conversation, such as the example of using random, forced photo sharing. The advantage of this approach is that it will not require a high level of context monitoring.

One possible way of embedding this approach is to let a mobile system suggest recently emerging topics on the table and make all members discuss them. As in the case of the icebreaking activity [26], the system may ask about a chosen topic and let users answer in order. For this experience, conversation visualization may be designed to include more intriguing elements. In the current iteration of Flower-Pop, the visualization was ambient and the effect on the conversation was limited. However, by imposing a penalty for situations where there are few utterances or utterances that are too dominant and result in exaggerated visualizations about them, it is possible to strengthen the fun experience during a casual conversation. Regarding photo sharing, the capability to randomly share all of the photos on a group member's smartphone was a potential privacy threat. Therefore, it will be possible to allow the participant of the conversation to preselect the photos that he or she is willing to share. This approach could allow group members to participate in conversations all at a fair level according to the established rules for a mobile system.

### 6.1.2 *Conversational Assistant For Supporting People*

Another alternative way of using mobile systems is to support users to become a skilled facilitator by using mobile systems as an assistant. When mobile devices had a coercive role (e.g., forcing participants to disclose their photo), participants might feel uncomfortable or ignore the system's instructions due to its lack of understanding of conversational context. Because the mobile system rarely understands diverse contexts in group conversations, the participants were visibly struggling to handle the problems of the mobile system. For this reason, it might be necessary to design a mobile system as an intelligent assistant that supports the person rather than leads the conversation. In situations where the mobile system does not understand the conversation context as much as a person, this approach allows a person to understand the context and make decisions as the mobile system provides the person with the necessary information.

For instance, if group member A's personality is passive and, therefore, he/she exhibits a low level of participation during a conversation, it would be inappropriate to disclose his/her participation level in public and force him/her to speak more. In such a situation, other group members might be able to draw out A's spontaneous participation by identifying what A's usual interests are, or what they have in common with the group, and by starting a story about A. During our study, G2-M3 (who was an active participant during a group conversation) mentioned that he wanted to know what an inactive participant usually liked. He shared the idea of showing other participants' photos in his mobile device rather than compulsorily and directly on the table. Then, instead of asking the inactive person about the personal information and recent experiences, and even forcing them to join in, he would be able to spontaneously introduce himself to the inactive person and ask the inactive person to take part. The inactive person might then become comfortable talking about himself and offer up his own experience in turn. Likewise, rather than forcing users to speak more or share the

conversation medium directly, we can design the system to inform other participants about each other's interests and related topics.

## 6.2 Research Issues in Utilizing Mobile Systems as Conversation Facilitators

As stated above, the use of a mobile system as a conversation facilitator requires further research despite its potential values. Then, how should a mobile system be designed and developed further to support casual group conversations? There has been the consensus that advances in artificial intelligence (AI) will make the conversational capabilities of computer systems vastly more sophisticated within three to five years. AI-powered assistants on our mobile devices and, more recently, in the home will allow us to interact conversationally with them. But user frustration levels with the conversational agents are beginning to rise. Although significant advances in machine learning have allowed conversational systems to better recognize speech, this capability has caused users to wrongly assume that these systems are also capable of understanding various sociocultural contexts of the conversation. As found in our study, one of the keys lies in helping computer systems to master one critical element for effective conversation—sociocultural context. Context involves many interconnected layers of accumulated knowledge that humans acquire and apply in conversation with little effort, but computers cannot yet amass—the atmosphere of the place, social relationships among members, their emotional status, etc. We suggest how further research should be conducted to enable mobile systems to understand and facilitate the context of casual group conversation.

### 6.2.1 *Consideration of the Characteristics of Places*

According to sociology and psychology research, people's current environments influence their social interactions [5, 14]. A place is a space that is invested with understandings of behavioral appropriateness, and places have their own personalities and act as social filters [35]. In our study, we found that participants were also cautious about the topic of the conversation and the choice of the picture due to their conversation in the public place. Participants primarily cared about maintaining social face in the public place. The abstract concept of face can be described as a combination of social standing, reputation, influence, dignity, and honor. The concept of saving face is a core social value in Asian cultures, among others. Saving face signifies a desire to avoid humiliation or embarrassment, to maintain dignity, or to preserve reputation. For this reason, it is assumed that a public space, such as a café, could be a constraint in casual group conversation while participants think about their social face.

Thus, several factors could be further considered, such as place type, crowdedness, and typical activity, to predict the nature of the place for more elaborate social interactions. A conversation facilitation system in particular might be designed to support the conversation differently in the private space and the conversation in the public space through sensing GPS or WIFI access information. In the private space, it would be okay if the manner of visualization is made clearer and more evident. If the types of photos are acceptable for the conversation group, then there will be no other limitation. However, in the case of public space, the method of visualization must be abstracted to avoid attracting others' attention. For photo sharing, it is necessary to consider the contents of photos and users' privacy issues.

### 6.2.2 *Consideration of Social Relationship*

Because there is no consideration of social relations in the present Flower-Pop system, it provides the same means of social interaction to participant groups. However, the system should be designed to support diverse methods of social interaction depending on the type of social relationship and the level of intimacy.

First of all, social hierarchy is one of the key elements that the system should monitor. In countries such as Korea and Japan, due to strict social hierarchy, people carefully select topics and manners during conversations [45]. Japanese individuals have special word forms that show respect or reflect greater formality and politeness. It is vital to observe these niceties in communication and companies may even train employees on how to use proper language to show respect to customers or superiors. Korean culture is strongly age sensitive and an age difference of a year or less may require deferential language from the younger party [23]. This implies that the roles of mobile systems as a conversation facilitator require further investigation on different social norms for various social relationships in a casual group conversation. In the case of friend–friend relationships, a rather rude or drastic interaction method is also possible (such as the case of disclosing photos as a penalty). However, more careful intervention is needed in the presence of groups with age differences, a relationship with a senior, or a child–parent relationship. For instance, if the system recognizes the senior, then the mobile system might be designed to support his/her ability to become a skilled facilitator by informing

group members' utterance levels and offering a hint about group members' personal interests. Then, they will be able to conduct the conversation in the way they typically do so within their culture. On the one hand, it might be possible to induce active conversation by enabling a conversation style that is unusual in this culture. For instance, it would be possible to induce the child or the subordinate to talk more often than seniors and supervisors.

Social intimacy is also a critical factor that decides conversation patterns. The social penetration theory, which is also known as the onion theory, mentions reciprocity of behaviors between people who are in the process of developing a relationship [1,5]. The behaviors vary based on the different levels of intimacy between communicators. The more intimate a relationship, the more in-depth the disclosure [12,18]. Furthermore, self-disclosure is reciprocal, especially in the early stages of relationship development [1]. In our study, the participants mentioned that different types of photos would be appropriate according to intimacy level. For instance, G6-F2 said that widely known facts, such as the weather and common activities or information about the location and time, would be good topics for the least intimate group. Several participants agreed that peripheral items would be exchanged more frequently and easily than private information at the beginning of intimacy building. G6-F1 mentioned that as a relationship grows and develops, the system may start to facilitate conversation about more personal items. Likewise, it is necessary to design a mobile system that concerns the level of intimacy among a group and causes them to disclose different types of content ranging from widely known objective facts and personal facts to subjective opinions and feelings.

While sensors in mobile devices cannot understand the social relationships between people, it is possible to use social networking services to surmise social relationships among group members. As attempted in previous research, social relationship and intimacy are evaluated based on the number of interactions in social media and the number of activities shared with other members. Also, content from a social networking site makes it easier to determine whether or not there is common ground with other members. Sourcing content from a social networking site requires little effort from users and exploits an already-curated resource that people use actively in self-presentation to their social network [41]. Also, the text in the post will become a good source to predict the topics and themes of photos in the post. In this way, the mobile system will be able to indirectly understand participants' social relationships and interests and support the participants in the conversation.

### 6.2.3 *Consideration On Audience's Emotional Status and Interest*

In a high-context culture, the method of conversation is more important than the content of conversation [9,21,47]. Accordingly, it is necessary for speakers to become aware of how others react and what their emotional status might be. The current version of Flower-Pop monitors whether or not a person is speaking and the system does not understand how audience members feel or react. However, mobile systems' technologies that measure an audience's interest and emotional status on a conversation topic might enable the smoother development of conversation, including shifts among topics and presenters.

There might be two possible directions for identifying an audience's status. First, understanding verbal communication will be useful to check audience members' apparent status and will enable deeper group conversation. While our system enabled conversation with broad topics by using photos, deep discussion about one topic was not possible. Since Flower-Pop was not developed to have the capability to understand the topic of ongoing conversation, some uncomfortable situations occurred during the study. For instance, the system interrupted the conversation by opening a new photo before the group had finished talking about a shared photo. Further, users had difficulties finding and sharing relevant photos at the right time. Despite these situations, the monitoring of verbal interaction will be able to support a group conversation in several ways. For instance, it might be able to suggest photos that are relevant to current conversation subjects. As participants spontaneously share photos to express sympathy and an intention to engage in a deeper conversation, the system may automatically detect relevant photos in personal devices and let users share them at will. Moreover, the system might be able to provide relevant information, such as photos, videos, or news, by searching them online and sharing on the table. Through this process, the system would support deeper conversation on a specific topic with richer information and proper manner.

Second, understanding nonverbal communication is also important to understand an audience's state of mind. Nonverbal communication comprises two thirds of all communication [3,22]. It includes the use of visual cues such as body language, proxemics, and physical appearance, as well as voice and touch [3]. Participants mentioned the importance of nonverbal interaction. Since nonverbal communication sometimes delivered more sensitive messages, it was important to listen not only to the words being spoken but also to how group members were speaking and the nonverbal messages

sent along. For instance, G3-F1 mentioned that she secretly studied other members' facial expressions to decide whether to continue a current topic or to bring up a new subject. She felt difficulties judging whether enough conversations occurred about a shared photo. By detecting nonverbal reactions, the mobile system may facilitate a group conversation in subtle ways [44]. For instance, in a casual group conversation, the mobile device may detect unconscious nonverbal responses, such as body orientation or nodding, to determine whether listeners are interested in the presenter's topic. Flower-Pop might also be designed to enable the shared photo to fade out when it judges that the excitement surrounding the current topic has diminished or the system can automatically suggest new photos with other new topics and naturally refresh the conversation.

### 6.3 Limitations

This research was exploratory, aimed at developing an initial understanding of the problem of developing a system to identify the impact of conversation facilitation with mobile systems and sociocultural aspects that should be studied further. We observed how people used Flower-Pop and conducted interviews to identify the underlying motivations that influence people's interest in meeting new people across different situations.

Despite the advances made by this research, there are limitations. In terms of the research process, the physical and social setting of the study is a methodological factor that probably affected the interactions observed between participants in the endeavor. We might observe different conversation patterns between group members in different settings; for example, with different group sizes and combinations of people regarding their backgrounds and levels of familiarity [27].

In terms of analysis, the results mainly consist of qualitative observations of the participants' activities during the group conversation, complemented with subjective opinions and experiences brought up in the interview. The qualitative approach allowed us to observe behaviors in an open-minded way, but also leads to the challenge that no precise comparisons between the effectiveness of this solution and a nontechnical solution, between the conversation patterns in Asian cultures and Western cultures, or among the impacts of different passive/active modes of Flower-Pop, could be attained. However, conducting a study to compare these aspects would require between-groups setup—as one group can be familiarized only once—and a very large sample of groups of participants. As the first exploration with this focus, we decided that a qualitative investigation would reveal more insights than an experiment this early in the research process. Throughout the experiment and subsequent analysis, we could confirm that the design of mobile systems for casual group conversation requires a deep understanding about sociocultural aspects that the current system did not support.

## 7 CONCLUSIONS

The studies presented in this paper showed that mobile systems including Flower-Pop have strong potential as a tool to actively facilitate a casual group conversation. This paper makes several contributions. First, Flower-Pop is proposed as an exemplar system that guides casual group conversations by monitoring and moderating photo sharing as an active facilitator. Second, the results of the field trial improve our understanding of how a mobile system is embedded in the context of casual group conversations. Focusing on Korea, our field study showed that our system's passive or active conversation facilitation supported live and animated participation in group conversations. Meanwhile, we examined the sociocultural influences on casual group conversation associated with the characteristics of a place, social relationships, and group members' interests and emotional status. Considering the impact of passive–active facilitation and sociocultural contexts in casual group conversations, we discussed research challenges and opportunities that could guide the design of mobile systems toward an intelligent conversation facilitator. As the intelligence of the mobile system is expected to develop progressively, our study will provide knowledge of designing a mobile system that is adaptive and appropriately responsive to a casual group-conversation context.

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