

SyncDecor: Communication Appliances for Couples Separated by Distance

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Abstract

Despite the fact that various means of communication such as mobile phones, instant messenger and e-mail are now widespread; many romantic couples separated by long distances worry about the health of their relationships. Likewise, these couples have a greater desire to feel a sense of connection, synchronization or "oneness" with their partners. This paper concentrates on the use of common, day-to-day items and modifying them to communicate everyday actions while maintaining a sustained and natural usage pattern for strongly paired romantic couples. For this purpose, we propose the "SyncDecor" system, which pairs traditional appliances and allow them to remotely synchronize and provide awareness or cognizance about their partners - thereby creating a virtual "living together" feeling. We present evidence, from a 3-month long field study, where traditional appliances provided a significantly more natural, varied and sustained usage patterns which ultimately enhanced communications between the couples.

1. Introduction

Although various means of inexpensive communication such as mobile phones, video phones, instant messenger (chat) systems, and e-mail are available, many romantically involved couples, separated by long distances, don't feel they adequately "keep in touch".

It is very difficult to define actual distance in a romantic "long-distance" relationship. Even if they are physically near, people who are deeply involved consider any form of separation a "long distance". This perception can be further dependent on other factors such as generational/age differences, area/location and economic/financial status. In this

paper, we define "long-distance" as the minimum separation distance required to cause difficulties within a romantic relationship which would not occur if both couples could meet on a regular, frequent and as needed basis.

In sociology there is a principle called "Bossard's Law" - we tend to marry (or date) someone who lives or works 20 miles from where we live or work. To work through this, couples today frequently stay in touch through various modern communication tools such as mobile phones, e-mail and instant messenger. However, explicit communication through these existing means have limitations in expressing "oneness" or warmth. In addition, many people are bothered or annoyed by frequent attempts to get in touch via tools such as mobile phones and e-mail.

In the study area of remote communication, this matter is widely recognized. There have been a number of papers discussing the enhancement of awareness between persons separated by great distances. In several research projects, the focus was to enhance awareness in houses that were located far apart. However, these systems reported differences in expectation and therefore emotional gain depended on the family member involved. For example, Peek-A-Drawer [11] focused on supporting communication between a grandparent and grandchild. It described that the frequency of usage and the acceptance of the system was different between the grandparent and grandchild - where the grandparent actively used the system but the grandchild did not. Moreover, Family Planter [12] focused on supporting a feeling of connection between family members living apart. It described that the difference in feeling and acceptance of a system depended on existing traditional relationship norms. To the question "Did you feel closer to the other person because of the system?" would elicit two different responses depending on the person. For example, from the parents of a married

son, they would reply positively. Conversely, the daughter-in-law, asked the same question, had a distinctively negative reply. Hence, in these experiments, the difference in the participant's relative position led to very asymmetric reactions and responses.

Compared to family members living apart (i.e. husband working abroad or grandparents and their grandchildren), we believe that romantically involved couples, separated by long distances, have a very similar strong motivation to communicate and bond. Similarly, in prior investigations, there were investigations more towards general inter-family relationships. Our paper talks about the unique situation where romantically involved couples want more interactive, impactful yet natural mechanism which enables a more connected communication environment and hence warmer relationship.

In our previous research [21], we presented the initial SyncDecor system using common, everyday objects that directly affect the participants, without requiring any extra effort on the participant's behalf, thereby enhancing connectedness through a seamless and natural communication environment. We now build upon the technical implementation from our previous paper and investigate the system more thoroughly - including after the participants "graduated" from the fun/novel stage. Additionally, based on feedback from the prior paper, this paper introduces two additional devices and goes to great lengths describing the results of their usage. Likewise, various unexpected/serendipitous uses of the various devices beyond its traditional/normal application were reported. Finally, this field test also collected numerous detailed system logs as well as participant journals which were analyzed for the findings during a longer 3-month period.

2. SyncDecor

The basic concept of the SyncDecor system involves the synchronization of pairs of daily appliances such as lights, trash boxes, and TVs - that are located at a distance from each other to create a virtual "togetherness" experience (see figure 1). For example, when a person turns on his/her light, the light of his/her partner also gets turned on at the same brightness or when a person throws away garbage, the lid on his/her partners trashcan would also move. Although these interactions are extremely simple, it enables the couple to share their daily activities with ease through the subtle awareness of each other's actions. If this couple were living together, these actions would happen naturally on a daily basis.

Therefore, to simulate this experience, this system eliminates the need to engage in special actions such as sending e-mail and therefore leads to a natural and sustained use. However, since this system is linked to one's daily routine, at times, it may be perceived as intrusive. Furthermore, it may lead to instances where one may curtail the use of a particular device, such as the lamp or TV, based on concern for the other partner. Nevertheless, even with these hurdles, couples who yearn for a richer, more connected and stronger relationship will overcome these hurdles to enjoy better communication by augmenting traditional means such as cell phones and e-mail. In effect, just like a relationship where the couples live together, this system creates an environment where the relationship grows stronger through the concern for one another.

We developed four prototype systems based on what most people interacted on a daily basis: SyncLamp, SyncTrash, SyncAroma and SyncTV.

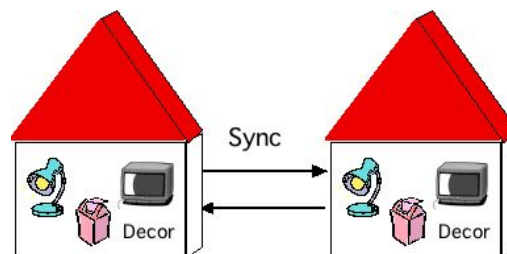


Figure 1. The concept of SyncDecor.

2.1. SyncLamp

Light can reflect our "presence", "state" and even feelings. SyncLamp is a prototype system for sharing the brightness of lamps between couples who live at a distance from each other (see Figure2). SyncLamp devices, like other SyncDecor devices are connected via the Internet. When a person controls the brightness of his/her lamp, his/her partner's lamp also changes to the same brightness.

2.2. SyncTrash

The disposal of trash can also reflect not only the "presence" of an individual, but our "activity" in the form of starting/finishing actions (e.g., eating).

SyncTrash is a prototype system for sharing the states (i.e. open and close) of the lids of trash boxes (see Figure2). When a person opens the lid of his/her trash box, the lid of the other distant trash box opens.

SyncTrash and SyncLamp mainly transmit his/her partner's "activity" or even wellbeing (i.e. how bad a person's cold might be), but we suppose that a person more actively uses the SyncTrash device for casual

communication than SyncLamp because the lid of trash boxes changes more dynamically and is transient in nature.

2.3. SyncAroma

In a prior survey and field test, we had received comments where male participants "felt" her presence by the smell of her perfume. As a result, we developed the SyncAroma system for synchronizing smells between couples and to transmit his/her partner's "feeling" and "state" through an alternative, non-visual medium. For example, the SyncAroma device may allow a partner to let the other know that he/she is relaxing or in a good mood or even that he/she has returned home. While the aroma pot isn't a daily necessity, the synchronization of aroma pots may allow for another medium to transmit ones feeling.

2.4. SyncTV

Again, in a prior survey, we received comments where couples want to share a similar TV viewing experience. As a result, we developed the SyncTV system for sharing a common TV channel, located in places that are distant from each other. When a person selects a channel to watch, the TV channel of the other person will also change to the same channel. From there, they will have common topics that may initiate other means of communication such as e-mailing or telephoning.

2.5. Other SyncDecor

Of course, there are countless number of SyncDecor devices that can be developed. For example, many people send e-mail's to each other just to say "Good morning." A device that synchronizes two alarm clocks may serve the same purpose. Overlaid with SyncLamp, it is possible to know whether the partner went back to sleep and/or needs to be re-awoken using a different method.

Furthermore, based on the survey, many participants expressed the want to hear the same music, synchronized curtains, microwave oven, fans and the like. We hope to implement these in future tests.

3. System Architecture

The system architecture of the SyncDecor is described in Figure 3. In this example, House A and House B each have a PC with a SyncDecor system attached. Each PC includes middleware software running on Ruby which controls the X10, Phidgets and

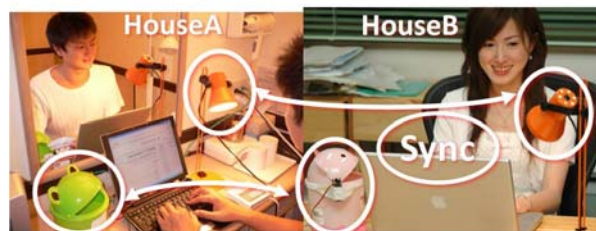


Figure 2. A pair of SyncLamp and SyncTrash devices.

IR servers. These two remote PC's are connected to each other via the Internet. When an action occurs on one of the PC's, it is sent to the opposing PC's server application via a separate and independent web server.

In the SyncLamp and SyncAroma device, an X10 controller is used. X10 uses the power-line as a means of communications and can effectively control AC powered devices. Given that the X10 uses the power-line as a means of communications, any electrical device within a residence can be conveniently controlled through this method. Likewise, other devices such as fans, air filter and room lights can be potentially controlled using this method.

The SyncTrash system consists of a pair of trash boxes with servo motors, foot switches, PC and a web server. The servo motor is equipped on the side of a trash box for opening/closing the lid and is connected to a computer with a Phidgets Servo device. The foot switch connects to the computer via a Phidgets Interface Kit. When a person presses the foot switch, a program on the PC opens the lid of the trash box by activating the servo motor.

The SyncTV system utilizes an IR device. The IR interface is accomplished through a USB based PC IR transceiver. After "teaching" the PC the remote control codes of a particular TV, it is possible to emulate that TV's remote control. Given the generic nature of the IR transceiver, it is possible to control numerous other IR based consumer devices such as VCR, audio player, air conditioners, lights and even fans.

These three interface mechanisms: X10, Phidgets and IR all have accompanying server software components which get abstracted at the middleware layer to allow for a flexible command structure to help in supporting future devices and allow for a simpler Ruby interface.

Finally, the two PC's effectively communicate via a central and independent server. This was done for four primary reasons. First, given the future potential of these devices and the uncertainty of the availability of a globally unique IP address, a server was needed to help connect to remote computers. Second, given the nature of firewalls, NAT's and other filters, it was

necessary to make a web based server which allowed control information to be transmitted as web traffic and easily traverse the network. Third, by having a centralized server, it allowed the system to filter the current actual state of a receiving PC before forwarding duplicate and/or redundant requests. Fourth, for testing purposes, it was a convenient and centralized location to store usage logging data.

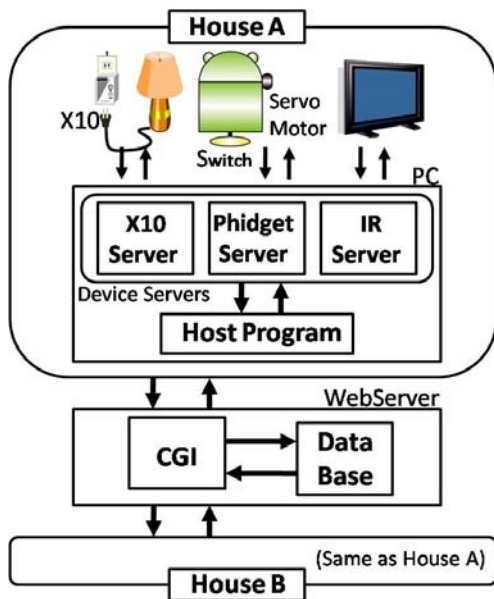


Figure 3. Overview of the SyncDecor architecture.

4. Field Test

In the previous paper [21], we carried out an initial field test with the SyncLamp and SyncTrash devices over a period of two months. The participants were a male (29-year-old office worker) and a female (24-year-old graduate student) living in different cities. The distance between the cities was about 600 km. They had been living apart for three years. We installed a pair of SyncLamp and SyncTrash devices in their rooms.

Based on the feedback from the initial field test, we then carried out this field test over a period of three months with the two additional couples (for a total of three couples - six participants) and the addition of the SyncAroma device.

4.1. The aim of field test

The aim is to reveal the following.
 Did the current SyncDecor devices support enhanced communication?
 Did the effects and feeling of SyncDecor depend on the type of SyncDecor device?

What other kinds of SyncDecor device is better suited for supporting enhanced communication?

4.2. How the field tests were conducted

We first surveyed the participants using a questionnaire before installing the SyncDecor devices. Basic information such as age, occupation, daily schedule and type of relationship were collected. In addition, we also asked about their daily communication habits.

Next, we installed the SyncDecor devices in their rooms and asked the participants to keep a daily journal to provide feedback on the SyncDecor devices. Separately, we recorded detailed system logs of the field test. In this test, we used the SyncLamp, SyncTrash and SyncAroma devices.

The first relationship was the same from the field test. They had almost the same living cycle and habit. The main means of communication were via mobile phone (once or twice per day) and e-mail (once or twice per day).

The second relationship was a male (24-year-old graduate student) and a female (24-year-old graduate student) living in different cities about 1800 km apart. They had been living apart for three years. They had roughly the same living cycle and habit. The main means of communication were via mobile phone (once per day) and e-mail (several times per day). Overall, they kept in frequent touch with each other using these methods.

The third relationship was a male (25-year-old office worker) and a female (24-year-old graduate student) living in different cities about 570 km apart. They had been living apart for two years. They had different living cycle and habit. The main means of communication were via e-mail (once or twice per day). They were not in frequent touch with each other.

4.3. Observation

The results of field test revealed the following. All participants actively used the SyncTrash device for casual communication. For example, they would open and close the trash box repeatedly to attract their partner's attention. The SyncDecor system often triggered the participants to initiate other means of communication such as e-mailing or telephoning. The couple felt certain "warmth," which was different from what they felt when engaging in just traditional means of communication such as just e-mailing or telephoning. Often times, they used SyncDecor as a "Good Morning" greeting and woke their partner up by opening and closing the trash box repeatedly. Some

sample journal entries included comments such as: "When I called him, he was sleeping. So I opened and closed the trash box to try and wake him up, but he didn't wake up. At this point, I felt a little angry." "I opened and closed the trash box and tried to wake her up. When she woke up, I was happy to get her attention." "I woke up because he opened and closed the trash box. Honestly, I was a little perturbed." During the initial experimental period, the participants regarded the SyncDecor system as novelty devices for explicit communication. However, after the early stages of field tests, they regarded them as a daily appliance with implicit communication capability.

Since the SyncDecor system used familiar, everyday objects, we also had cases where the participant's family also took part in the communications. Specifically, where the participant lived together with their family, the other family members became interested in the SyncDecor system and went into the subject's room and frequently enjoyed interacting with the SyncDecor devices. In one journal entry, "He got home early and turned on the lamp. I was not at home but my family noticed that the light was turned on and sent me a message stating his early arrival." In this case, he didn't send a message to her about his early arrival. However, the family sending her a message about his early arrival added a different level of closeness to the relationship. While this was a rare use case, the subject's family became part of the relationship.

Using the system, each member of the couple could feel the daily activities of the other. Moreover, we had many instances where couples guessed their partner's state by the movements of the SyncDecor system as in this quote: "I felt a bit of hesitation about opening the trash box because I came home late. However, after I opened it, I didn't receive feedback from her and assumed she must be sleeping". The effects of SyncDecor system also depended on the participant's lifestyle. In this sampling, the male participant usually lived alone in a small apartment; the female lived with her family in a large home. As a result, the male participants were more sensitive to the movements or activities of a SyncDecor device. Similarly, in the case where SyncTrash was installed in the female's room shared with her sister, her partner was more concerned about her sister than her. As a result, the male participant avoided unnecessary opening and closing of the trash box. In another example, when a male participant's parent stayed at his home from an extended period of time (one month), the female participant, who normally used the SyncDecor system quite frequently, noted her curtailed use of the system in deference to the parent's visit.

Furthermore, the effects of the SyncDecor system depend on the participants' living schedules. For example, a couple having different schedules didn't get many chances to show each other's "live" activities via the SyncDecor system such as seeing their lamps and trash box change state. As a result, they developed an alternate use for the SyncDecor system. For example, the male participant left the light on when he left for work. When the female's participant woke up and saw the lamp, this extra action or "thought" itself made the female participant happy. Afterwards, when she left home and turned off the lights, he also felt certain "warmth" when returning knowing she instinctively took that "extra" step for each other. Therefore, this modification in the use of the SyncDecor system allowed couples to quickly and easily convey a simple yet warm message.

The mood and demeanor of the person affect how the SyncDecor system is used. For example, during the field test, all three couples experienced some level of quarrel. All three male participants tried to mend the relationship by using the SyncDecor system. Eventually, it was determined that the SyncDecor system was effective in minor tussles, but wasn't effective (even counterproductive) during serious fights. This was noted in the following journal entry: "I was still in bad a mood, but when he tried to improve the situation using the SyncDecor system. I went from bad to worse."

Finally, the frequency of use depended on each devices. The SyncTrash was used most frequently for explicit communication purpose because the lid of trash boxes changes more dynamically and is transient in nature. On the other hand, participants didn't use the SyncAroma device as frequently because they didn't have the habit of using aroma pot or the habit of initiating smell.

4.4. Discussion

First, we answer, did the SyncDecor system have any effect on the romantically involved participants by enhancing communications? Based on post research survey of the participants measuring traditional communications (i.e. number of phone calls and e-mails) before and after the SyncDecor system was installed, four participants said there was no significant change. Two participants specifically mentioned that their initial communications increased mainly to confirm the proper functionality of the SyncDecor device. However, based on the questionnaire regarding whether or not they thought more about the other person, five participants said that their feelings for the other had increased. Within this group of five, several

mentioned that they became more cognizant of the others and started wondering what the other was doing - including even hesitating to use certain SyncDecor devices so as not to bother the other person. The remaining one participant mentioned that they thought less of the other. However, this was actually the result of the SyncDecor system providing feedback letting the person know when the other was at home or not - leading to reassurances about the persons wellbeing and hence less worry and therefore further thought.

Based on the results, we feel that the communications between distant couples were enhanced through the use of the SyncDecor system.

Next, we will discuss the difference in how the various SyncDecor devices were used and felt. In figure 4, we show results from the log data obtained from the server during a 3-month span. The X axis describes the time in weeks. The Y axis describes the number of requests sent to the server during that particular week. The three lines in the graph describe the total SyncTrash, SyncLamp and SyncAroma usage/request from the six participants.

Compared to the other device, we found that the SyncTrash device was used the most. We believe that this is because the device was actually used on a daily basis for disposing of garbage. Furthermore, it can be assumed that since the device visualized the mouth of an animal (see Figure2), it enhanced the communication paradigm through its actual movement. In the diaries of the participants, it was even noted that the SyncTrash device was used explicitly for initiating other forms of communication. However, as seen in figure 4, after the initial novelty of the device wore off, the usage leveled off to a more natural day-to-day usage pattern. This was within our expectation, proving how a natural device allows for natural usage and isn't forgotten or fades completely from usage once the novelty wore off.

Based on the survey, four of the participants felt that the SyncTrash device was the most useful. As seen in figure 4, the other two devices (SyncLamp and SyncAroma) usage was lower than the SyncTrash device. In this experiment, we found that certain participants were either not in the habit of using a desk and therefore a desk lamp and/or that existing room lighting did not need to be augmented by a desk lamp. Based on this observation, it clearly shows that something which is not a day-to-day object leads to overall lower usage rates. If however, the light source was something more day-to-day (i.e. room light), the results would most likely be different. Nevertheless, two other participants felt that the SyncLamp device was the most useful communication tool given that, unlike the SyncTrash device, it was not transient in nature (i.e. either stays on or off).

In regards to the SyncAroma device, four participants mentioned in their survey that they used the device based on its novelty, but that their interest quickly waned due it not being a normal action.

Based on this observation, it can be concluded that a device had higher usage if it was a normal daily object that did not require proactive effort above-and-beyond natural usage patterns.

Finally, based on the participants survey, we would like to discuss what other devices would be better suited for this type of remote communication. Some examples, based on the participant's responses included a warmth synchronized bed and synchronized open/closing of curtains. Furthermore, several participants who had different living schedules wanted the ability to view past logs. Specifically, this feature was requested based on this system synchronizing actions whether both parties were present or not. Therefore, when both parties were on different schedules, there was an increased need for seeing what actions had taken place. With the SyncDecor system in place, the parties knowingly expected some sort of togetherness. Therefore, perhaps making log data available can help alleviate that.

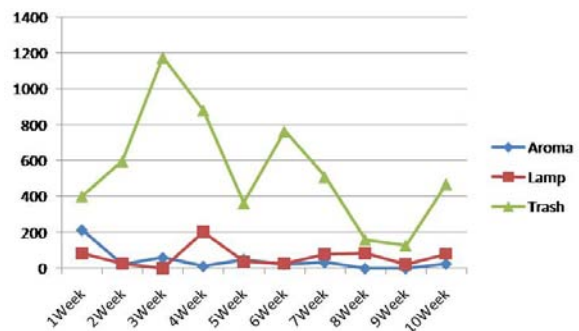


Figure 4. Usage graph of the various devices over a 10-week period.

5. References and Citations

Many research projects have explored the issue of remote awareness. Digital Family Portrait [15] is one of several electronic picture frames that can display the daily activities of family members who live far from their families. For example, it could be used to display the daily activities of an elderly person who lives far from his family. The aim of this research was to support family members living apart. Presence Displays [6] are physical displays which show the online presence status of close friends and family. Feather, Scent, and Shaker [17] are elegant design

based systems that enable long-distance couples to communicate.

MeetingPot [16] is a device that can inform people of a coffee break, in a common office area, by using the aroma of coffee. Physical awareness proxies [14] and [9] convey a remote user's (mainly co-workers or laboratory members) availability, using a tangible interface. Tangible Bits [11] enables users to be aware of background bits at the periphery of human perception using ambient display media such as light, sound, airflow, and water movement in an augmented space. Building Flexible Displays for Awareness and Interaction [8] described a set of flexible ambient devices that can be connected to any available information source and that provide a simple means for people to move from awareness into interaction. Virtually Living Together [20] described presence by representing the interaction of people with everyday objects such as stones, chairs and portraits. The Casablanca project [10] explores how the media space concept could be incorporated into the household and family life.

In these examples, the devices were designed for asymmetric, one-way communication, which separate the user sensing portion from the information presenting function, thus having no immediate or natural relationship between the user's action and the corresponding remote display. These devices are more passive in nature and only enhance awareness of weaker feeling and ties. We propose devices for symmetric, bi-directional (two-way) communication that combine both the sensing of user action or situation with a correspondingly similar information presentation. In doing so, we support and motivate communications between romantically involved couples, separated by long distances.

Peek-A-Drawer [16] provides virtual shared drawers across distant locations. LumiTouch [2] is a pair of photo frames, and ComSlipper [4] is a pair of slippers to indicate the activities of a partner who lives far away. ComTouch [3] converts a pressing force to the vibration of the corresponding ComTouch device. FeelLight [18] is based on a communication scheme based on a 1-bit button pressing action. VIO [13] shows color changes over twelve hours. The final image displays the remote partner's VIO state. inTouch [1] is a part of communication devices with cylindrical rollers that rotate synchronously between two distant people. RobotPHONE [19] is a Robotic User Interface (RUI) that uses robots as physical avatars for interpersonal communication. Using RobotPHONE, users in remote location can communicate shapes and motions to each other. Lover's Cup [5] is a communication tool for drinking-together interaction between long-distance couples.

The bed [7] is a bed environment that creates the virtual existence of a person (who lives far away) in a bed.

These investigations were optimized more towards communication mechanisms that are more "passive" or casual in nature. Our paper talks about situations where romantically involved couples want more interactive, impactful yet natural mechanisms which enable a more connected/realistic communication environment and hence warmer relationship.

Moreover, SyncDecor tries to reflect a person's actions directly onto the remote devices. Our design is based on the synchronization of familiar, everyday objects, without modifying their original function. SyncDecor system can create a virtual "togetherness" experience.

6. Conclusion

We have described the SyncDecor system, which pair remotely installed appliances and electronics so they may synchronize with each other. The objective of this is to create a virtual "togetherness" that enables the couple to share their daily activities with ease through subtle awareness of each other's actions. We built four prototype systems - SyncLamp, SyncTrash, SyncAroma and SyncTV and had three, long distant, romantically involved couples (six participants) using these devices in a normal, day-to-day setting collecting numerous logs and usage diaries. Based on this usage, we determined the unique ways "feelings" were conveyed through the SyncDecor system as well as the different ways the various devices were utilized within them.

In the future, based on the data received, we hope to enhance the system and expand the number of devices to cover even more day-to-day objects. Similarly, while the field test was of a limited sample size, the variances in personal schedules and habits of each participant provided several interesting results in the fully networked, long distance setting. Given the daily 3-month "real world" usage, with actual romantic couples brought out numerous issues and unique findings that would not be apparent in an experimental laboratory setting.

Finally, since we presented a system that leveraged familiar commonplace items, it did not require any extra training or interpretation to use. This allowed for participation beyond the principal romantic parties involved and created instances of spontaneous interaction (and provided additional findings) from other individuals (i.e. family members).

7. Acknowledgments

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8. References

- [1] Brave, S. and Dahley, A. inTouch: A medium for haptic interpersonal communication. Ext. Abstracts CHI 1997, ACM Press (1997), 363-364.
- [2] Chang, A., Resner, B., Loerner, B., Wang, X. and Ishii, J. LumiTouch: An emotional communication device. Ext. Abstracts CHI 2001, ACM Press (2001), 313-314.
- [3] Chang, A., O'Modhrain, M.S., Jacob, R.J.K., Gunther, E. and Ishii, H. ComTouch: Design of a vibrotactile communication device. In Proc. of Symposium on Designing Interactive Systems, 2002, pp. 312-320.
- [4] Chen, C.-Y., Forlizzi, J. and Jennings, P. ComSlipper: An expressive design to support awareness and availability. Ext. Abstracts CHI 2006, ACM Press (2006), 369-380.
- [5] Chung, H., Lee, C.-H. J. and Selker, T. Lover's Cups: Drinking interfaces as new communication channels. Ext. Abstracts CHI 2006, ACM Press (2006), 375-480.
- [6] Dey, A. K. and de Guzman, E.: From awareness to connectedness: the design and deployment of presence displays, CHI '06: Proceedings of the SIGCHI conference on Human Factors in computing systems, New York, NY, USA, ACM, pp.899.908 (2006).
- [7] Dodge, C. The bed: A medium for intimate communication. Ext. Abstracts CHI 1997: ACM Press (1997), 371-372.
- [8] Elliot, K. and Greenberg, S. Building Flexible Displays for Awareness and Interaction. Video Proceedings and Proceedings Supplement of the UBICOMP 2004.
- [9] Greenberg, S. and Kuzuoka, H. Using Digital but Physical Surrogates to Mediate Awareness, Communication and Privacy in Media Spaces. Personal Technologies, 4(1), January 2000, 182-198.
- [10] Hindus, D., Mainwaring, S. D., Leduc, N., Hagstrom, A. E., and Bayley, O. Casablanca: designing social communication devices for the home. In Proc. CHI 2001. ACM Press (2001), 325-332.
- [11] Ishii, H. and Ullmer, B. 1997. Tangible bits: towards seamless interfaces between people, bits and atoms. In Proc. CHI 1997. ACM Press (1997), 234-241.
- [12] Itoh, Y. Miyajima, A. and Watanabe, T. "TSUNAGARI" communication: Fostering a feeling of connection between family members. Ext Abstracts CHI 2002, ACM Press (2002), 810-811.
- [13] Kaye, J. I just clicked to say I love you: rich evaluations of minimal communication. Ext. Abstracts CHI 2006, ACM Press (2006), 363-368.
- [14] Kuzuoka, H. and Greenberg, S. Mediating awareness and communication through digital but physical surrogates. Ext. Abstracts CHI 1999, ACM Press (1999), 11-12.
- [15] Rowan, J. and Mynatt, E.D. Digital Family Portrait Field trial: Support for aging in place. Ext. Abstracts CHI 2005, ACM Press (2005), 521-530.
- [16] Siio, I., Rowan, J., Mima, N. and Mynatt, E. Digital Decor: Augmented Everyday Things. In Graphics Interface 2003, PP. 155-166, June 11-13 2003.
- [17] Strong, R. and Gaver, W. Feather, Scent, and Shaker: Supporting simple intimacy. In Proc. of CSCW 1996, ACM Press (1996), 29-30.
- [18] Suzuki, K. and Hashimoto, S. Feellight: A communication device for distant nonverbal exchange. In Proc. of the 2004 ACM SIGMM Workshop on Effective Telepresence, (2004), 40-44.
- [19] Sekiguchi, D., Inami, M., and Tachi, S. RobotPHONE: RUI for interpersonal communication. Ext. Abstracts CHI 2001. ACM Press (2001), 277-278.
- [20] Tollmar, K., Junstrand, S., and Torgny, O. Virtually living together. In Proc. Designing Interactive Systems 2000. ACM Press (2000), 83-91.
- [21] Tsujita, H., Siio, I., and Tsukada, K. 2007. SyncDecor: appliances for sharing mutual awareness between lovers separated by distance. Ext. Abstracts CHI 2007, ACM Press (2007), 2699-2704.