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RemoTable: Sharing Daily Activities and Moods Using Smart Furniture

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Abstract. Social Interaction and the feeling of emotional closeness to beloved ones is mainly driven by the communication with each other. For patients suffering from a serious disease due to intense mood changes, it is difficult to keep regular contact with relatives. This affects the need for direct and verbal communication with relatives. To continue the participation in each others lives, we have developed a concept to share daily activities, current moods and presence information using a smart living room table. A first lab study with a prototype showed promising results with regard to expressiveness, joy of use, and usability.

Keywords. smart furniture, social awareness, interactive tabletops, nonverbal communication, participation

1. Introduction

The need for ongoing social participation and empathy are often the main reasons for interpersonal interaction between patients and relatives. This strong desire for communication and a feeling of closeness is even more important for people suffering from a serious and deadly illness. Patients and relatives often need to communicate their feelings, needs and wishes to support each other and to better cope with the situation [8]. Therefore, the extended need for communication and the support of an ongoing communication with others is one of the key needs in palliative care [3,12,4], especially when relatives and patients live over a long distance from each other.

Due to the serious illness, patients in palliative care do often feel helpless and are subject to changes in mood during their everyday life. These changes often affects a patient's need for direct communication with others, either personally or by using verbal communication channels like the telephone. However, although patients might not want to get in touch verbally occasionally, they still want to feel socially integrated and keep in touch with their loved ones. Relatives as well, often have issues with keeping up the communication with patients, because a) tasks in their ongoing life do not allow them to communicate as much as they wanted to or b) some relatives might be uncertain in how to deal with the illness and how to start a communication with patients [13]. Due

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to their own anxiety, some people might reduce the social interaction with the patient, which in turn leads to even bigger communication barriers. Enhancing and simplifying interpersonal communication for patients and relatives reduces the risk for additional psycho-social problems [11]. At the same time, new and extended means of communication can assist patients over a distance to keep in touch with relatives and close friends more easily, and therefore, support both patients and relatives to cope with the situation.

Exchanging the execution of daily activities e.g. eating with beloved ones supports the feeling of being part of the family and can motivate to get in contact. However, it is very likely that keeping in touch using verbal communication means, such as phone calls or messages can become too obtrusive and disturbing. More pervasive communication technologies can support the non-verbal and everyday communication of emotions and activities more adequately.

2. Related Work

Tee et al. have explored the communication patterns among family members, who live spatially apart from each other [10]. Their study shows that most of the participants had a strong need to communicate more often and more regularly with family members than they actually did. The work reveals that people miss out on communicating with each other due to asymmetries in their daily routines. When designing communication technologies, it is important that the user doesn't feel obliged to send messages or to share information. On the contrary, the technology should help the user to feel connected with others in a positive way in case they feel like it.

Kaye et al. & Kjeldskov et al. have researched the needs and requirements for technologies to support a feeling of closeness and to understand the role of intimate communication in the users lives. [6,7]. The results showed a desire for new technologies to support communication by providing presence information and activity awareness for a loved one. Users want to feel a connectedness with each other, provided by e.g. a single light which is displaying physical presence of the other person. The requirements for such communication devices allow the design of simple devices and interactions based on a "minimal communication". Further Kaye et al. presented the concept of intimate objects [5]. These objects are meant to support couples living over a distance to create and maintain a feeling of presence and intimacy between each other.

Brereton reports in her work "Habituated objects" [1] results from an interview about objects of greatest significance to an elderly person. Particular attention is paid to how objects are configured to suit needs and interests, and how these objects become habituated into life over time. This provides helpful insights into how design strategies should make use of these habituated objects to support staying in touch. It is further important to understand to which extend objects and technologies have been adopted and habituated in users life, and why some technologies fail to do so. This work provides clues to design new IoT-technologies that support elderly people. Further Vaisutis et al. [11] have presented categories for important objects of daily living, based on interviews with users above 65 years. They could show that objects often inherit a specific connection to memories or events from the past.

Lenz et al. [9] describe four different concepts to lower the barrier of getting in touch for families living over a distance. The work underlines how important the creation of

positive and meaningful experiences is, when designing for such communication technologies. It further describes that it is crucial to use technology sensibly to shape new ways of communication and exchange of information about a beloved one.

3. Requirements

We wanted to gain insights into the needs and requirements of people living over a distance with regard to their communication behavior, the use of everyday objects, and activities. Further we asked about possible use scenarios to share daily activities and moods. Gaining these insights, helped us to understand the potential use of everyday objects as non-verbal communication means. The requirements show, that people frequently perform daily activities at tables in different contexts of use. This led us to the idea of designing a smart table as a means of non-verbal communication between people living over a distance.

In a first step we conducted semi-structured interviews with eight participants (n=8) within a age range from 17 to 55 (5f; M=33,63 years; SD=15,56). Results showed, that most participants use tables throughout their day depending on their current activity. The most mentioned tables within the homes were living room tables, kitchen tables and desks to work on. For younger participants, the desk within their own room seemed to play a more important role. Adults often mentioned the living room table as the most used one. Objects used on or near the tables are often matching the currently executed activity e.g. using a mug to drink coffee together, reading a book or the newspaper or working on the computer. Objects on the tables that did not match a specific use case are mostly decorations and flowers. We asked the participants about their normally conducted activities, when sitting at a table. The most prominent activities were: *eating dinner*, *using the smartphone*, *drinking coffee*, *working on a computer*, *reading* and *watching TV*.

Following, we have asked the participants about the information they would like to get about distant family members or friends using smart furniture. *Mood of the other person (6)* and *activities in the other household (5)* were the most mentioned information. Additionally to that, *health-related information(4)* were especially interesting, when communicating with elderly persons. Further mentioned information are: *general information from the family (2)*, *pictures (1)*, *location (1)* and *visitors are present*. The question how this information should be visualized was answered with: *color for mood (3)*, *pictogram (3)*, *emoji (2)*, *color for activity (2)* and *text (1)*. When interacting with the furniture, users liked the idea to use day-to-day objects and tangibles to represent their current mood (7/8). Additionally to that, some participants mentioned to use touch gestures or buttons to input information or to connect their smartphone with the furniture and use that to interact and input data.

4. Design Concept: RemoTable

Based on the requirement analysis, we have created an interaction design which enables a nonverbal exchange of presence, activities and moods using smart furniture in the form of a living room table. Following we describe the concepts for three different use cases and the prototype of the RemoTable.

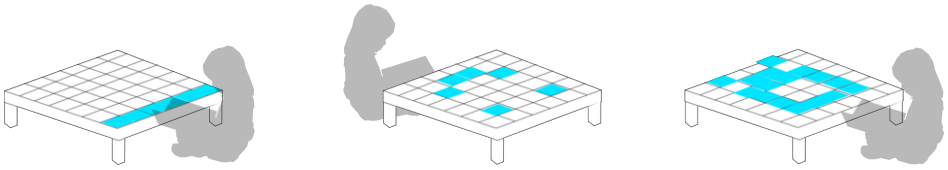

Figure 1. Use scenarios implemented for the RemoTable - showing presence of distant people (left), recieving mood visualization (center) and receiving information about activites of a beloved one.

4.1. Exchange Presence

By sharing the presence of related persons sitting or standing at a connected table, we aim to create a feeling of closeness between both households. When distant persons are approaching the connected RemoTable, a proximity sensor detects their presence and transfers this information to the local table. This information is visualized by lighting up the pixels on the corresponding side of the local table (see Figure 1 - left illustration). Seeing that a beloved one is at home and using the connected table, helps to get a sense about the persons availability.

4.2. Exchange Moods

The most mentioned information during the conducted interviews, was the current mood of a connected person. We wanted to enable users to express their current mood easily and without much effort, to simplify the communication. Compared to nowadays normally used messaging services, the RemoTable is only able to present a limited amount of information using a limited space. Therefore the visualization of moods should be clear to perceive and interpret. We decided to build on existing methods to express moods using emojis (see Figure 1 - center illustration). This decision is based on a) the wish for emoji during our interviews, b) existing models to classify mood and c) a high level of awareness for emoji nowadays. By placing one of five tangible emoji in the form of a small token on the table, the user can express her/his current mood. This mood is saved in the system, until a new token is placed and transferred to the connected table. To visualize the mood of a related person on the local table, we have created digital versions of the available emoji, that get shown on the table's surface (see Figure 3). Adding new emoji or ideograms in the future is easily possible and might help to express moods and feelings even better.

4.3. Exchange Activities

Besides the exchange of moods throughout the day, the second most wanted information is what activities are currently executed in the distant household. To support this, we want to utilize the detection of objects placed and used on the table. Therefore, objects that relate to a specific activity and are used often during the day are equipped with electronic tags. This enables the RemoTable to detect these objects and transfer this information to a distant connected table (see Figure 1 - right illustration). Because the tags are being read automatically, there is no need for explicit communication from the user. This has two main advantages: 1) The user can not forget to share her/his activity and 2) the interaction with the RemoTable is easy and natural. For a later use-scenario, we imagine

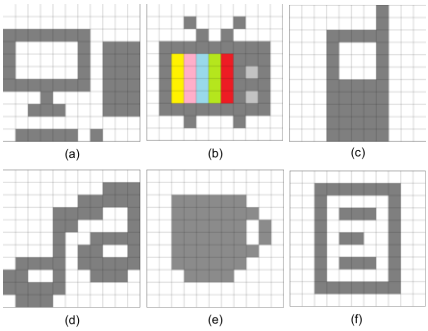

Figure 2. Resulting symbols used to represent activities on a low resolution display.

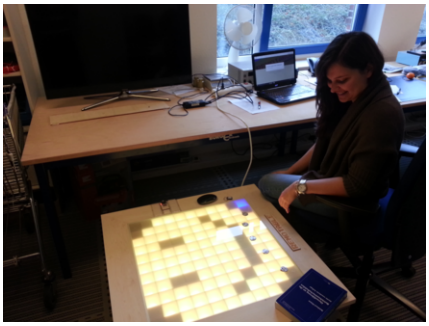

Figure 3. Participant during the study, receiving a shared mood from a connected person.

that users can add tags to objects them-self, which removes possible concerns about privacy protection, e.g. the user decides what object to tag, and therefore what activity to share. Similar to the visualization of moods, we have decided to use pictograms to present activity information at the local RemoTable. A subset of these pictograms are depicted in Figure 2. This subset shows corresponding symbols for the most common activities at the tables. a) using the computer, b) watching TV, c) using the smartphone, d) listen to music, e) drinking coffee/tee and f) reading.

4.4. Prototype

The prototyping process was based on the requirements and the defined use scenarios. The design of the prototype was also driven by the ambition, to create a device which does not appear too technical and integrates well into the living environment of younger and older adults. Therefore, we decided to integrate a low-fi light display into a common living room table instead of using a modern display. In the set-up of the first prototype, we have used a Raspberry Pi to enable the communication using WiFi as well as to store information and to control the visualization on the display. The display consists of 121 individual controllable RGB-LED lights, creating a matrix of 11 x 11 pixels. To control the lights and visualize the content on the matrix, we use a Arduino Mega prototyping board. For reading the RFID-tags applied to different objects, we us a RFID-reader device connected with the Raspberry Pi. On top of a wooden raster, containing a single LED each, a frosted glass is placed to cover up technical parts and to better diffuse the light from the RGB-LEDs underneath. The whole technical setup is depicted in Figure 4. All visualization on the tables surface are event-based. Meaning, that if a new event occurs, the receiving table exchanges the last shown information with the new message (either presence, mood or activity of the connected person). To keep the setup simple, which is sufficient for a first lab evaluation, we have designed the system to connect two tables together. However, we also have integrated tags to identify the person who is sharing information, by placing a tag on the table to register. This is especially important, when the table is used in a household with more then one inhabitant. By lighting up one of the corner-squares in a predefined color, the receiving table visualizes that a specific person has registered before sharing a message. To present the information in an unobtrusive way, the table will fade out the light-display after some time and turn of.

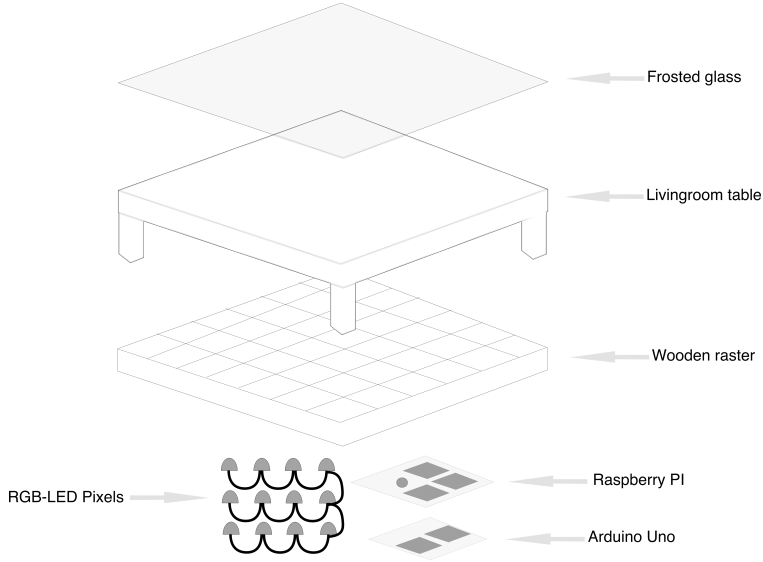

Figure 4. Technical design of the RemoTable

5. Study

The study aimed at assessing three main aspects of our concept which are a) usability and user experiences aspects of the device, b) comprehensibility of the pictograms and emoji and c) support of the communication with distant family members. These aspects were measured using post-study interviews and questionnaires.

5.1. Study Design & Procedure

To investigate the above mentioned factors, we have designed a lab study in a controlled environment. Based on the use scenarios, we have developed a wizard-of-oz communication with a virtual communication partner, which is pretending to communicate with the user. We achieved this by implementing a simple system, that is able to react to messages from a participant by sharing a mood or an activity respectively. This helped us to evaluate the RemoTable with regard to usability and user experience, as well as how such a device might be able to support communication with beloved ones over a distance. After explaining the device to the participant, s/he was able to try out the device and ask questions, without any time restrictions. In a next step, the participant was told, that s/he will communicate with another person, who also using a second table in another room. To communicate with the virtual partner, the participants were asked to execute specific tasks e.g. sharing an activity, sharing a mood. If no questions were left, we started the communication. After completing the tasks, each participant was asked to answer a SUS-questionnaire [2] as well as further questions based on the ABCCT- questionnaire by Yarosh et al. [14]. Following we have conducted a semi-structured interview, to get more insights into the user experience as well as possible usability problems. After completing the interview the study ended.

5.2. Participants

We have recruited 14 participants in the age from 18 to 55 (9 female; M=30.5 years SD=11.99 years) from the local university, personal contacts, and via public announcements. The participants did not receive any incentives for their participation. Due to an ongoing ethical clearance, we were not able to involve palliative care patients in our field study. Nevertheless, the results show tendencies of how people perceive activity and presence information and showed promising results with regard to expressiveness, joy of use and usability.

5.3. Results

Following we present the results from the study conducted within our lab. The results are categorized in three main parts a) regarding the usability of the RemoTable, b) the ability for the device to support communication and a feeling of closeness over a distance, and c) further qualitative feedback and possible extension for the system.

5.3.1. Usability

The SUS score for the RemoTable was very high (M=89.46, SD=7.08). Hence, the Usability of the RemoTable was rated as excellent. Additionally to the SUS-questionnaire, we have asked the participant how they perceive the two different input methods (sharing mood and sharing activities) and if they like to use them as a method of interaction. Both interaction methods were rated very good and participants strongly agreed that they like to use them. Both were rated with a median of 5: Input of moods (Figure 6 (EE): M=5, IQR=0) and Input of activities (Figure 6 (EA): M=5, IQR=1). We further asked them if they would like to have an undo functionality, that enables them to remove a shared mood or activity after sending it for within a specific time frame. Most participants disagreed and therefore, do not see the need for such a feature (Figure 6 (LN): M=2, IQR=2.75). Additionally we asked the participants, if they can imagine to use the table to freely draw on it using a smartphone or a touch input and share these drawings with the communication partner. Most participants liked the idea, that they can be creative and express them-self by drawing simple pictograms (see Figure 6 (EZ): M=4, IQR=2.75).

5.3.2. Support for Communication

Results from our questionnaire, regarding the support for communication, revealed that the RemoTable has a high potential to support a feeling of closeness between distant family member or friends. Results have been measured using a Likert-scale (1-never to 5-always) and are depicted in Figure 5. Participants reported, that they were able to identify how the communication partner feels (Q1: M=4.5; IQR=1) and were able to share their own mood respectively (Q2: M=5, IQR=1). Further participants reported to have enjoyed the use of the RemoTable for the communication with each other (Q3: M=4.5, IQR=1). Participants agreed that the use of the device would supports them to feel connected with each other and keep in contact during the day-to-day life (Q4: M=4, IQR=1). The question, if the communication partner might feel obligated to communicate with them using the RemoTable was declined by most of the participants (Q5: M=1.5, IQR=2). Additionally, most participants had no concerns, that they can not fulfill expectations regarding the communication using the device (Q6: M=2, IQR=2.75). We could not find

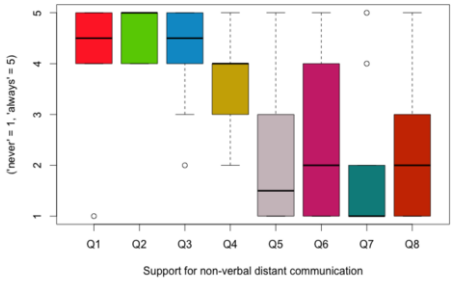

Figure 5. Results of the post-study questionnaire regarding the support for non-verbal communication usign the device.

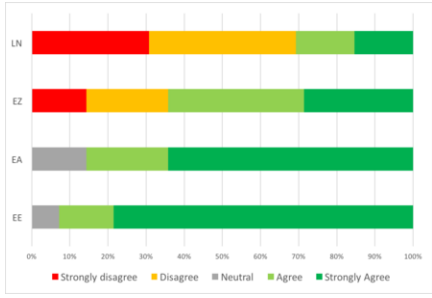

Figure 6. Results of the post-study questionnaire rating different input methods to interact with the device.

evidence for any possible privacy concerns using the device (Q7: M=1, IQR=1). Further the participants did not report any concerns, that third people could get to know what has been shared using the RemoTable e.g. current moods or activities (Q8: M=2, IQR=1.75).

5.3.3. Qualitative Feedback

During the study multiple participants underlined the simple usage of the device and that illustrations shown on the display can be perceived easily and without misinterpretations. Some participants described the RemoTable as *innovative* and reported a high *joy of use*. One participant mentioned: *"The table is very innovative and combines everyday objects with communication. Sharing messages that way can replace writing lengthy text messages."*. Another participant summarized: *"The table can give me a very good impression of whats going on at the other place, because my relation to family member is very intimate. This is easy and faster than using WhatsApp or Facebook, which I could use later one to ask more specific questions."*. We also received more negative feedback for the RemoTable. Some participants mentioned that the display could have a higher resolution to be able to depict more details and more complex pictograms. One participant noted, that the display should change direction, depending on what side the person currently sits. This can be easily integrated, due to the fact that we already use distance sensors to detect presence near the table. Further it was mentioned, that the ability to read tags should not be restricted to a specific area, but to the whole table surface. As an addition to the current functionality, participants mentioned the wish to have history of the shared moods (8/14) and activities (6/14) over a longer time e.g. one week. When asked if the participants would exchange their currently used living room table with the RemoTable, eight of them agreed. When asked if they can imagine to extend their current table with a more flexible display e.g. integrated into a tablecloth, eleven of them agreed.

6. Discussion

We can not yet conclude if such social awareness systems are able to increase the direct and verbal communication between communication partners that do live over a distance.

Although we got interesting and important insights in the usage of such devices, we further need to investigate deeper into how such devices have an effect on peoples communication behavior. Another interesting aspect of this would be, if the additional non verbal communication channel leads to more verbal communication because the awareness of the communication partner is raised or if the verbal communication decreases because a form of communication already happened. In our study we were able to gain insights about communication behavior of healthy people.

However, these results might change to some extend, if the communication happens between a terminally ill patient and a relative. For example, sometimes it may be hard for the relative to call the patient, because the expression of feelings and thoughts is hard or even impossible. In such a case, the ability to use a non verbal communication channel may allow the relative to express that s/he is thinking about the patient without the need of talking or writing about inexpressible thoughts and feelings. Unfortunately, due to ethical reasons, this could not be studied yet. However, since our results show that simple information about activity and mood can express much more information for people knowing each other, the ability of non verbal communication channels might be a very powerful tool for distant living people.

7. Conclusion & Future Work

We presented requirements and results from a first study for the design of a smart furniture to convey information about day-to-day activities, presence and moods of a beloved one. We proposed the design of an ambient light display integrated into a smart table to exchange activity information between people living over a distance. We based the encoding of information on results from a user-centered design process conducting semi-structured interviews and design sessions. Results show that sharing and receiving information about the activities of a beloved one is fun and might lead to more engagement in verbal communication. Users reported the use of the device to be a fun experience and a playful way to express moods and day-to-day activities.

In the near future we aim to extend our study with patients and relatives to research how the use of such communication means can affect peoples social awareness about loved ones and how this might change communication patterns with them. It is also interesting if such communication means can support patients and relatives to better cope with a serious illness and helps them to overcome episodes of helplessness especially when relatives and close friends are not co-located with them.

8. Acknowledgements

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