



A social cloud-based tool to deal with time and media mismatch of intergenerational family communication



Diego Muñoz^a, Raymundo Cornejo^b, Francisco J. Gutierrez^a, Jesús Favela^b, Sergio F. Ochoa^{a,*}, Mónica Tentori^b

^a Computer Science Department, Universidad de Chile, Av. Blanco Encalada 2120, Santiago, Chile

^b Department of Computer Science, CICESE, Carretera Ensenada-Tijuana 3918, 22860 Ensenada, Mexico

HIGHLIGHTS

- Differences in preferred media obstruct social interaction with older adults.
- A mismatch in interaction rhythms also makes difficult the communication with elders.
- SocialConnector bridges this gap by connecting the elderly with their families.
- Older adults perceive low effort for socializing when using SocialConnector.

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ABSTRACT

Social media services are increasingly used to support social interaction among young people and adults. Older adults however, are often reluctant to use social media services, and prefer to socialize through face-to-face meetings or telephone conversations. Moreover, the time periods that family members have for socializing can be different, as they may have a different schedule for conducting activities and commitments during the day. These differences in media preferences and scheduling times for socializing generate a communication asymmetry that socially isolates older adults and negatively impacts their physical and mental health. Based on the analysis of a dataset from two 21-weeks deployment studies and nine semi-structured interviews, we conducted an in-depth formative study trying to understand the communication asymmetry among older adults and their relatives. The results were used to improve the design and implementation of *SocialConnector*, a cloud-based application that enables older adults to conduct synchronous and asynchronous social interactions with their relatives. The usability of the new system was evaluated to determine if its services contribute to address the stated communication asymmetry. The obtained results provide evidence that the system can successfully help to alleviate the communication breakdowns led by asymmetries in media and time preferences among family members.

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1. Introduction

An increasing amount of the social interaction performed by adults and young people is supported by digital media (e.g. email, social networking services and videoconference); however, older adults are reluctant to use these technologies for socializing. Consequently, elders become more and more socially isolated, which negatively impacts their physical and mental health [1,2]. To help address this problem, the authors developed a ubiquitous application named *SocialConnector* [3], which uses cloud services to allow

older adults to socially interact with their family community using a touch-screen and voice commands. The system is designed to facilitate its adoption by older adults who are first-time computer users by means of a seamless and natural interface.

The purpose of *SocialConnector* is to act as a mediator that consumes and processes data stored in the cloud, making it available to a third party, specifically to older adults (Fig. 1). While in a typical family community there is an intention among its members to communicate with each other, we acknowledge that each party has his/her own preferences, which might be not negotiable [3]. Therefore, the communication process may not be effectively completed, thus negatively impacting older adults by discouraging socialization. Then, the main challenge that needs to be accomplished by *SocialConnector* is the need to hide behind a usable interface the inherent complexity of retrieving, processing and transmitting information from the cloud. This information is mostly generated

* Corresponding author. Tel.: +56 22 9784879; fax: +56 22 6895531.

E-mail addresses: dimunoz@dcc.uchile.cl (D. Muñoz), rcornejo@cicese.mx (R. Cornejo), frgutier@dcc.uchile.cl (F.J. Gutierrez), favela@cicese.mx (J. Favela), sochoa@dcc.uchile.cl (S.F. Ochoa), mtentori@cicese.mx (M. Tentori).

by other family members (e.g. through Facebook wall messages, emails, or short text messages), and respecting their communication media preferences.

An initial prototype of SocialConnector was evaluated for usability and usefulness, from which several strengths and weaknesses of the tool were identified [3]. Particularly, the need to address the asymmetry between the media preferences and the interaction time spaces of the family community members appeared as a mandatory software requirement. This finding is also supported by the authors' previous study [4], which goes a step forward in the analysis of this asymmetry and shows that it is a consequence of the differences (in terms of technology adoption) between the several generations of community members.

A typical Latin-American family includes at least three generations including young people, adults and older adults. On one hand, young people usually prefer social networking services and instant messaging systems to perform their social interactions; adults prefer email and mobile phones; and older adults use wired telephone, face-to-face meetings and written letters. These differences in media preferences generate a communication asymmetry among family members, since older adults rarely use the media used by young people to socialize. This issue has also been identified in other similar studies [5,6] and it is exacerbated by the speed at which new communication services are being incorporated, typically by the younger generations. One such example is the Whatsapp service: created in 2009, it recently reached 500 million users and surpassed Facebook, Skype and Twitter as the social messaging service most used in many countries. Older adults who do not use a mobile phone then become excluded from using this popular communication media tool.

On the other hand, the time periods that family members have for socializing depend on the activities they perform during the day. Typically, the time schedules at school or college affect the availability of teenagers for socializing with other family members, and the job schedule affects that of adults. In the case of older adults, they usually have an ample space because they are typically retired, but might not be available at night. Therefore, these people have to frequently manage their availability in order to make possible the social interaction with other family members. The misalignment in time and space that each family member has available to socialize reduces the chances for socialization. This is an additional restriction that contributes to increase the asymmetry between the social spaces of family members.

This paper presents the results of a preliminary formative study that helps understand intergenerational social interaction within families, including the described asymmetries. The study consisted on collecting a set of semi-structured interviews, which were later transcribed and analyzed using qualitative research methods. The obtained results were used to motivate the redesign of SocialConnector, which was then evaluated by nine older adults using the paper prototyping and thinking aloud techniques. The obtained results are highly promising and show that an important part of the stated asymmetries would be addressed with the use of SocialConnector.

The following section presents the related work. Section 3 describes the study conducted to understand communication between elders and their families, and it also presents and discusses the findings. Section 4 introduces the SocialConnector system and its main components. Section 5 evaluates the new design of the system involving real users. Thus, we have tried to determine if the system redesign is usable and useful according to the older adults' opinion. Section 6 shows how the main findings of the study were addressed through the new design of the system. Finally, Section 7 presents the conclusions and future work.

2. Related work

Typically, older adults do not have broad access to information and communication technology, or they have difficulties when using it [2]. This problem is exacerbated for those with physical or cognitive impairments, and as a result, many older adults report feelings of loneliness and an increased longing to communicate or interact with family or friends [7,8]. The World Health Organization [9] considers older adults as a group of people aged over 60; however, it is important to note that in terms of HCI, age alone does not define this group. In fact, according to Moffatt [10], social groups are defined by their common characteristics, with individual membership depending on a number of factors that vary by context and from person to person. Therefore, while we try to understand communication patterns in intergenerational family communities, we recognize that these members can actually behave quite differently, and these differences need to be taken into account when extracting and trying to generalize behavioral patterns in the same group.

With the proliferation of devices supporting ubiquitous access to communication technologies, and the prevalence of social media for connecting family and friends, it is likely that older adults face increasing challenges in interacting with their younger relatives who use such technologies to socialize [6,11]. Therefore, a theoretical understanding of the connection between communication aspects and health indicators will advance human-centered computing, by motivating the design of interfaces and awareness mechanisms that promote wellness by increasing the interaction opportunities for older adults [12].

Tee et al. [13] conducted a study involving parents and grandparents in order to examine how people use existing technologies to communicate with their extended family. They found the following challenges faced by the communication parties: (1) coordinate a time slot for allowing communication; (2) overcome the perceived effort for initiating an interaction, especially when using interaction mechanisms other than talking (e.g. sharing photos); (3) overcome the apprehension and perceived obsolescence towards technology; and (4) overcome social challenges perceived as an obligation and consideration for extended family members. Moreover, the study found that there is a communication pattern that reflects a strong interest in children, and particularly grandchildren. In particular, these findings motivate the need of understanding communication asymmetries in intergenerational family communities.

Cornejo et al. [14] studied the role of ambient awareness within intergenerational families in order to observe the quality of communication and relationships, especially in older adults. The authors found that, on one hand, younger relatives partially circumvent the communication barriers (e.g. technological abilities, geographical distance), and build empathy and social connectedness by sharing photographs, activities or comments with emotional content through social networking services. On the other hand, some older adults have relatives acting as proxies to show them the information shared in these social systems, while others rely on face-to-face interaction and telephone communication to keep in touch with relatives or learn about their activities. Several works on social emotion recognition [15] can also be used to improve the connectedness between elders and the rest of the family.

In the context of understanding the existing communication uses and needs among older adults, Riche and Mackay [16] conducted a study aiming to identify the key aspects of these adults that affect their independence and well-being. The authors found that some forms of communication do not involve explicit sharing of messages, but rather an on-going awareness of the other person's state. That is, people tend to use both personal and environmental cues to help them interpret what is happening to the other

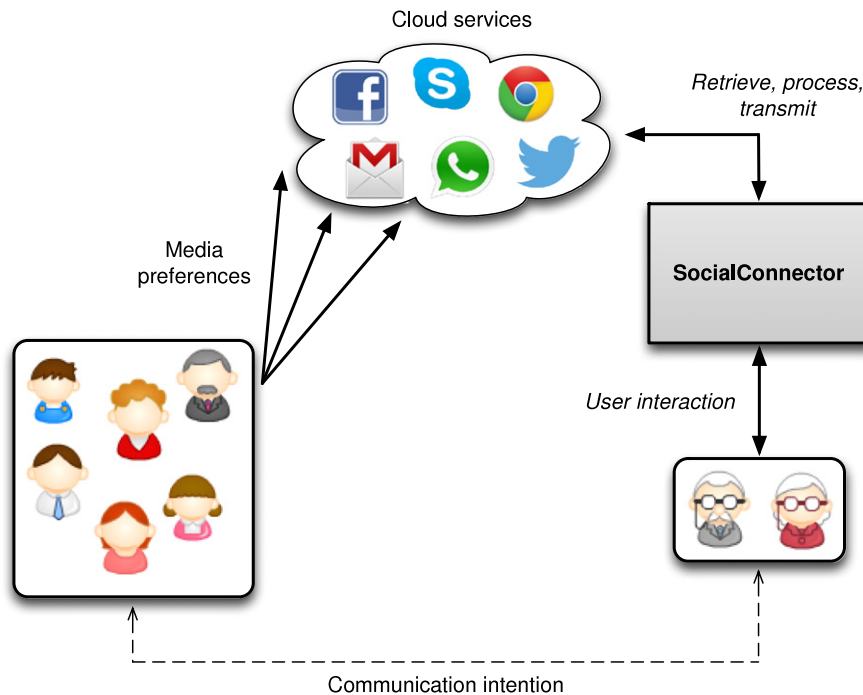


Fig. 1. Communication asymmetry among members in a family community.

person. Moreover, communication routines and rhythms have an important role when interacting with others. In particular, this shows that asymmetries can be studied in at least two dimensions: (1) media preferences; and (2) availability and willingness to communicate with other family community members.

Since we would like to align communication asymmetries across family communities, and recognizing a broad spectrum of media preferences including digital interaction, we need to support video-mediated communication. In fact, in this type of interaction users tend to use this medium for bringing a sense of closeness with the people they communicate with [17]. Moreover, it is important when designing video-supporting systems to consider mechanisms that allow people to easily deduce other's availability and willingness to video conference, as well as providing access to people for easily sharing everyday activities [18]. When considering communication with members in distant places, this interaction is typically affected by the misalignment of daily schedules between the two parties, due to the different time zones. In this scenario, Cao et al. [19] found that asynchronous communication is recognized as more flexible, but in the practice synchronous communication is preferred for facilitating an emotional connection among family members.

Ames et al. [20] studied the practices around videochat in a familiar scenario, including remote relatives. Video is perceived as a means to create, enact and reinforce family values even at a distance. Families put considerable work into balancing the various needs of their members, from children to grandparents, in deciding when and how to keep in contact. Regarding the perceived benefits of videochat, it is considered as an alternative synchronous means of communication that has more available supports than traditional interaction channels, such as telephone calls. Nevertheless, even if the former apparently seems to require more work for being used, the greatest benefit of video communication is its capacity for providing remote family members (e.g. grandchildren and grandparents) with an apparent sense of presence, and allowing getting to know one another better than they could with only voice support.

According to Judge et al. [21], despite the fact that video conferencing allows remote family members to socially interact in a

synchronous way, most of these systems are designed for phone-like calls between only two locations. Therefore, the authors designed a media space to support shared video between different locations. However, even if this approach to solve the problem of social connection seems promising (i.e. it increases presence awareness), it may raise privacy issues, usability and accessibility concerns when dealing with older adults.

When envisioning the design of software support for social interaction and social presence, there are additional issues to be considered [22]: (1) overcome the limitations of technology to provide presence awareness; (2) maintain face-to-face contact especially for supporting the interaction with older adults; (3) consider heterogeneous preferences of social media; (4) provide the possibility of mutual social interaction; and (5) properly address usability and accessibility concerns.

Finally, in any socio-technical system, there are both symmetries and asymmetries present in the design of the technology and also in the ways that the technology is appropriated [23]. When supporting intergenerational communication between older adults and their closer relatives, an asymmetrical pattern emerges. In fact, the grandparent–grandchild bond is an important emotional relationship in a human's life and very close to the parent–child bond. A strong relationship between grandparents and grandchildren benefits both parties [24], but the lack of technological support makes this relationship more difficult to build and maintain [25]. This asymmetry in the communication patterns is also expressed in terms of the media preference of both parties in the process. This preference can be explained by their technical abilities or merely by how comfortable they feel using different media [26,27].

Although these studies have helped us understand the role of social media to support individuals' interactions, they have not particularly addressed the communication asymmetry described in this article. Our proposal deals with this challenge, although it considers only the asymmetry between older adults and their relatives. This represents a first step towards addressing the communication asymmetry in a broader sense.

3. Design study

We conducted an in-depth formative study, aiming to inform the design of SocialConnector. This study was conducted using qualitative research methods, as they are widely used when human and social factors are involved in the design and development phases of computing systems [28].

Data collected from two 21-weeks deployment studies [4] were analyzed to expand the understanding on older adults and relatives' availability management, media preference and communication commitment. To further understand communication routines, coordination, and media preferences, we complemented our previous dataset with nine semi-structured interviews we conducted with adults and older adults. All of the recruited participants regularly stay in touch with relatives or friends living in Mexico and the United States. During interviews, participants were asked demographic information and were encouraged to describe stories, and discuss what they found interesting or different while communicating with their relatives and friends, and overall communication media preferences.

Interviews were conducted face-to-face or through Skype; in the latter case, the older adults required a proxy member to establish the video call for the interview. Interviews lasted between 20 and 90 min ($M = 38$) and were audio recorded. Recordings were listened and relevant or valuable segments to the interview questions were transcribed. Following data analysis methods from [29], we analyzed the data gathered to identify categories and its relationships. We uncovered emergent themes in relation to availability management, media preference and communication commitment, and possible connections among participants in terms of the themes described above. Transcripts were read several times by a second author to identify relevant categories, and following axial coding, the found categories were analyzed to determine their possible relationships among them. Categories and its relationships were used to derive affinity diagrams [30] to represent the core categories. Meetings were held with the research team to discuss and corroborate emergent themes for each iteration of the analysis.

3.1. Dataset and interview participants

Twelve transcripts were selected from the prior dataset based on the relatives' locations—scattered through Mexico and the United States. We selected one older adult (female), three children (all female), six grandchildren (three female), one grandniece and one nephew.¹

In addition, nine participants were recruited from Mexico (2), Colombia (3), Chile (2) and Argentina (2) to take part in the interviews. Four of these participants were older adults (age: 66–76, $M = 72$, $S.D. = 4.55$), and five adults (age: 24–47, $M = 33.4$, $S.D. = 9.71$). The occupation of older adults included two housewives, a university teacher, and a retired medical doctor; occupations of adults included two IT consultants, a computer engineer, an employee of a distributor of goods for kiosks and a university professor.

All older adults participating in the design study lived with their spouse, had at least one child living away, and did all their activities of the daily living without any assistance. All but one of the older adults have used computers at least once as a communication tool (e.g. chat, email or Skype); however, their main communication medium was either a telephone or a mobile phone, and one older adult still used postal mail. Telephone calls were their primary

communication medium to stay in touch with their relatives but they also used mobile phones to call their relatives; however, they rarely used mobile phones to send text-based messages (i.e. SMSs). Postal mail was used mainly to send memorabilia to their relatives or emotive message on special dates (e.g. birthdays). In contrast, young adults have used a broad range of communication media (e.g. social networking services, email, and mobile phone) to stay in touch with family and friends. Moreover, young adults have used postal mail occasionally to send important documents. All the parents of the young adults interviewed were living in a different city than their offspring.

3.2. Design findings

The findings from our study suggest three main design insights that should be taken into consideration in the development of an interactive communication system to facilitate socialization between older adults and their relatives.

3.2.1. Balancing media use

The increased diversity of media use across generations creates communication asymmetries making it difficult for users to communicate with each other. For example, some younger adults expressed how suitable were social networking services since they allow to send asynchronous messages where others were more inclined to use email as they preferred asynchronous communication medium.

Prior research indicates how older adults might have a limited access to modern communication technologies, creating an intergenerational communication gap. Our results indicate that this might not be exclusive between generations. Although young adults adopt rather easily new media, they usually have one or two preferred media as their main choices to communicate. This creates a communication gap, not only with older adults, but also with their friends and relatives.

A1²: *"I do not have problems using any system [referring to IM, chats, email, etc.] but I prefer email to stay in touch".³*

This media preference is emphasized in older adults, where they heavily depend on face-to-face interactions or traditional communication media, such as telephone, to stay in touch with their relatives.

A5: *"I only use the telephone [to stay in touch with my grandparents]. And I try to avoid using email with my family"*

Young adults felt obligated to use more traditional communication media to stay in touch with older adults; therefore, they could not use their preferred communication media. This tacit understanding among adults of media selectiveness in order to stay in touch was not reciprocal by the older adults. Older adults did not state the need of learning how to use new communication technologies to stay in touch with their relatives. On the contrary, they kept using traditional communication media, no matter if they did receive an answer though a different communication media or if they did not receive an answer at all.

OA1⁴: *"I send them greeting cards or photos by [postal] mail, and then they call me to thank me"*

Therefore, media preferences create inherent communication asymmetries. Incorporating a contact repository component into a communication system that bridges the diverse media used across generations might alleviate the problems of asymmetries. This component should collect contact information of each relative and their preferred media.

² A = adult participant.

³ Participants' quotes were translated from Spanish to English, and some were adjusted to fit English grammar conventions.

⁴ OA = older adult participant.

¹ Further participants' details can be found in [31].

3.2.2. Easing communication practices

Younger adults showed no need of having pre-arranged meetings with their peers unless it was with older adults. The flexibility of using several communication media allowed them to stay in touch regardless others' routines and communication patterns. As stated by A5, younger generations, in some occasions, use different media depending on the importance or the length or complexity of the shared information, even if they tend to have a preferred media.

A5: "It depends on what I am doing or want to say. If it is something short I would use instant messaging, but for something more complex I would use my [mobile] phone".

It seems that younger adults use the affordances that each communication media provides, to decide what media is more adequate depending on the context of use and the information that is being shared. Each media has its own interaction model, usage rules, and affordances. Due to the current availability of a myriad of social media services, older adults find it difficult to learn each media usage rules and prefer to use traditional communication practices. Furthermore, traditional media have no availability indicators and the process to start communication relies on knowing the routines and patterns of the people with whom they want to stay in touch. This increases difficulty as stated by OA3, where communication systems include more indicators than traditional communication media, which seems to be somehow confusing for older adults.

OA3: "I do not understand all of it, sometimes I think pressing a button [referring to the availability status] will have unexpected results, so I avoid [doing] that".

A communication system that integrates the different affordances of each communication medium might promote social interaction among its users. Nevertheless, this multifunction support should simplify the interaction of each communication medium to ease the use for older adults.

3.2.3. Availability awareness based on routines and patterns

Informants reported being generally conscious of the daily routines and communication patterns of their relatives and friends whom they wanted to stay in touch with (e.g. older adults consider the job schedules of their relatives during weekdays).

OA5: "I know their schedules, and I try to estimate their availability".

Similarly, relatives showed some awareness of their peers' schedules; however, adults had the sense that older adults were more available than their other peers, due to older adults being retired. As OA5 stated, in occasions this perception by younger adults tends to generate some concern in older adults of not being available when needed.

OA5: "...the only schedule I am worried [of not being available] is when I am taking a nap and this is the time they would be available".

The uncertainty associated to knowing if others are available comes from prior knowledge acquired from explicit tasks, which can vary in long term or due to unexpected events where participants modify their routines. Therefore, older adults had strategies, such as planning communication times in advance, to ensure availability from both parties. Communication systems can ease the process of pre-arranging communication sessions by either encompass the patterns and routines of their users, and explicitly inform participants' availability or allow asynchronous communication when routines conflicts occur among participants. The importance of being available seems to be closely related to the routines and patterns of participants, and the capabilities of using diverse communication media. Matching the routines and patterns of close relatives and friends might alleviate the older adults' tensions to manage communication times and promote social interaction.

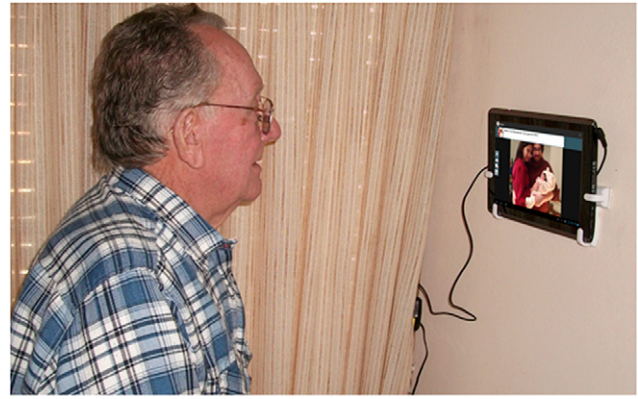


Fig. 2. Older adult using the SocialConnector.

4. The SocialConnector system

SocialConnector is a cloud-based software application that facilitates the social integration of an older adult with the rest of his/her family using social media. As shown in Fig. 1, adults and young members of a family community use regular social media to interact among them, and also to socialize with older adults. Provided that the latter typically do not use regular social media, they use SocialConnector as an intermediary social that eases such an activity. This intermediary has a loosely-coupled relationship with regular social services available in the cloud (e.g. Facebook, Skype and Gmail). Therefore, this application interacts on-demand with these service providers. The availability of a service provider is not a constraint to use the SocialConnector, since the data supporting the social interactions of elders is locally managed in each device.

The user interface of SocialConnector is simple and it is deployed on a slate (Fig. 2). Elders interact with the application using their voice and by selecting icons on the touch-screen. They perceive this solution as similar to a telephone that allows various communication alternatives.

In order to preserve a telephone metaphor and to ensure the system availability when required, the slate is fixed to a wall and the SocialConnector is active at all times. However, during the night (at sleeping time) the system turns off the device screen simulating that it is really turned off, and during the morning it becomes again available for the user. Next sections describe the system architecture, the rationale behind the main design decisions and the new system prototype.

4.1. System architecture

The architecture of the solution considers young and adult people socially interacting using cloud services through a Web browser (Fig. 3). SocialConnector acts as an intermediary between these services and the user interface utilized by the older adults to interact with the rest of the family. Particularly, the I/O service interface is in charge of translating the asynchronous messages retrieved from cloud services to the data format used by the SocialConnector messages and vice versa. Thus, this component suggests each participant that their counterpart is using the same interaction mechanism, although in fact they are using different tools. Such a strategy allows addressing the previously described asymmetry of social media preference for family members.

The solution also considers the *community administration module*, which is an application connected to the cloud allowing some family members to configure the "family community" that is visible for an older adult. The *community repository*, indicated as a cloud service in Fig. 3, is in charge of providing data persistence

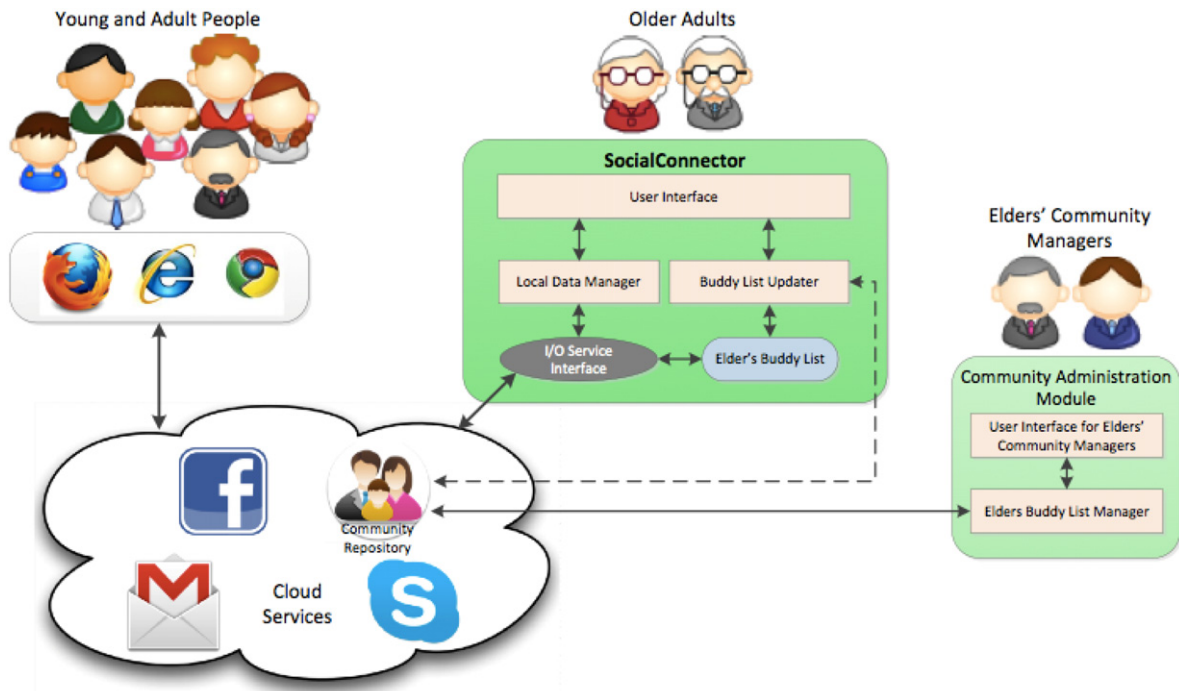


Fig. 3. Basic architecture of the SocialConnector.

to the family communities. This service is used by SocialConnector to keep updated their local buddy list (i.e. a list with the users that are members of a community), and also by the community administration module, in order to create and update such a list for a particular community. Next, we describe the main components of this solution and also the key services that make possible to address the stated asymmetry.

4.2. SocialConnector

SocialConnector implements four communication channels through which the older adults can interact with regular social media services (Fig. 4): (1) videoconferences; (2) private messages; (3) public messages; and (4) a photo display. By default, the *videoconferences* are Skype video calls; therefore elders must have a Skype account. The interaction with the video call service is managed by the *I/O service interface* of SocialConnector. Similarly, the *private messages* are emails (provided through a Gmail account), and the *public messages* are messages in the Facebook wall. The *I/O service interface* also manages the interaction with these social media services. Particularly, this component translates the message structure from the original format to one that can be understood by the receiver application. This must be done because SocialConnector manages its own structure for the public and private messages. This structure allows the tool to implement particular awareness mechanisms, self-adapt their services and exchange messages with several social media tools.

The *photo display* service embedded in SocialConnector is an output channel; therefore it does not allow a direct interaction between the person who publishes a picture and those who watch it. These photos usually act as a mechanism to trigger interactions among older adults and the family members (e.g. liking a photo).

Each communication channel has its own user interface. In order to initiate a video call, the user accesses his/her contact list (i.e. the buddy list) and indicates the person to be contacted. Fig. 5(a) shows the contact list of an older adult, where we can see who are available (e.g. Sergio and Carla) and unavailable to contact (e.g. David). This awareness mechanism allows addressing, at

least partially, the requirement raised by the participants in the presented study, which indicates that people want to know when the person to be contacted is available for interaction.

Fig. 5(b) shows the interface to visualize private messages (i.e. emails). The older adult can reply to these messages using voice communication. A speech to text translator helps create the email that will be then sent to the target contact. Fig. 5(c) shows the public messages interface and Fig. 5(d) presents the photo display (shared pictures). This last service, which was implemented by integrating the Tlatoque system [4], allows the slate to act also as a digital frame during the periods when there is no activity on the device.

The buddy list representing each community is kept in the cloud, and is accessible through the *community repository* service. Such a buddy list acts as the master copy for all community members. Therefore, SocialConnector periodically accesses the cloud service (through the *buddy list updater*) to determine if the local copy of such a list is updated; and eventually updates it.

4.3. The community administration module

The local buddy list stored in the elder's device includes the owner's record (his/her personal information, and the information to access the diverse communication channels) and a list of contacts. These contacts can play one of two roles: manager of the buddy list or regular contact. The first ones are in charge of creating and managing one or more buddy lists using the community administration module. This module is a Web application that can be used to create a buddy list for an older adult and manage it accordingly by adding/removing contacts, changing roles to the buddy list members, and also changing the attributes of the buddy list owner and his/her contacts (e.g. photo, contact name and email account). The following structure summarizes a buddy list of an older adult.

```
[owner ID, name, photo, range age, email address, Skype username, Facebook username, preferred communication media],
{[contact ID, role]}
```

The buddy lists can be overlapped, and a contact can play different roles in different buddy lists. For instance, the common contact in Fig. 6 can be the owner of the buddy list B (typically an

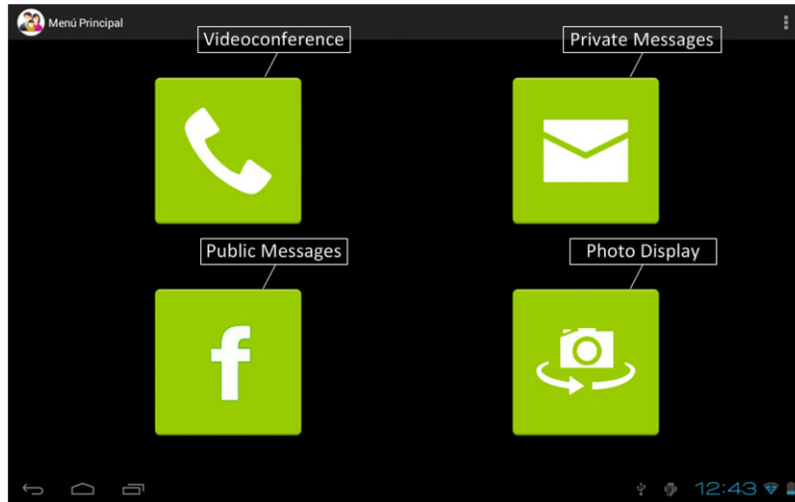


Fig. 4. SocialConnector main user interface.

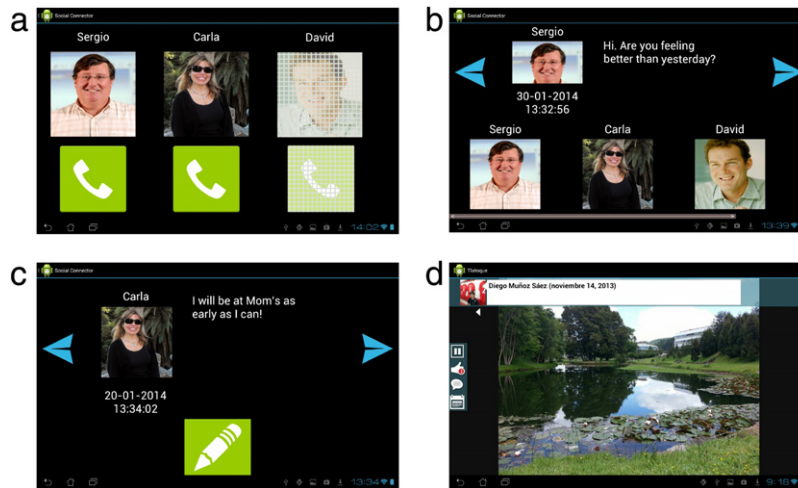


Fig. 5. User interfaces of the SocialConnector services.

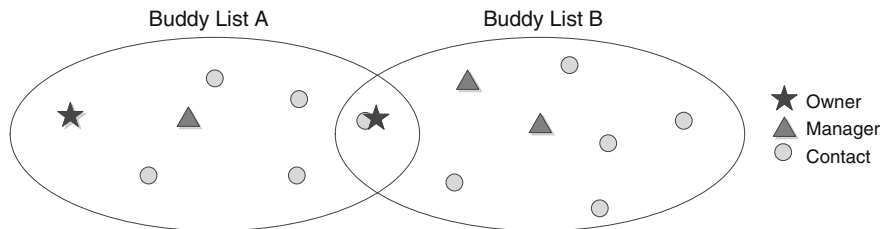


Fig. 6. Example of two overlapped buddy lists.

older adult) and a regular member of the buddy list A. This type of buddy list configuration allows older adults to include not only family members, but also neighbors or friends whom they might want to communicate with.

A contact can be reused if he/she already belongs to another buddy list. The community repository exposes the Web services that allow this and other components to perform these operations.

4.4. The community repository

This service is available in the cloud and accessible through an URL. It provides persistence to two components: the *buddy list* and

the *activity log file* of each community. The buddy list is represented as an XML file that is stored on both the *community repository* and the older adult's device. Therefore, SocialConnector does not need to access such a service provider to start an interaction process. The buddy list also stores detailed information about each contact, which allows the system to properly support the interaction. The contact record has the following information:

[contact ID, contact name, photo, gender, age range, familiar relationship, email address, Skype username, Facebook username, preferred communication media]

Some personal information like gender, age range and familiar relationship (between the local user and the contact) are not particularly relevant for the system services, but they are useful for

analyzing interaction based on the log file data. The preferred communication media of each contact helps the system select the most appropriate channel to interact with each user.

In addition, the activity log file of an older adult is kept in the *community repository* as a way to have such information available when required, and also to provide a logical order (in terms of the sequence of events) to the interaction records. The current log file structure is the following:

```
[owner ID, {activity ID, source contact ID, destination contact ID, timestamp}]
```

4.5. Interaction filtering

In order to keep the social interaction of older adults protected, the system filters the content that these users may access through the slate. For instance, they can receive messages or interaction requests only from members of their contact list. Any attempt of other people to interact with the elders will be automatically rejected or blocked by the system. For each communication channel, the system acts as a filter that shows information related only to the contacts that are contained in the buddy list. Particularly, the interaction through the *videoconference* channel is filtered by the system comparing the buddy list of the SocialConnector and a synchronized list between Skype and the Android Contacts app. The system user interface shows the list of people that can interact through videocalls with the elders. Skype manages incoming calls; therefore the system can only filter outgoing calls.

In the case of the *private messages* channel, the system downloads from the email service provider the messages that have been sent or received by the members of the buddy list. Such message retrieval service was implemented using the JavaMail API. In this way, the user will never receive undesired messages (e.g. email ads, spam). For filtering *public messages*, the system uses the Facebook Query Language to download messages that contain only plain text, which were published by Facebook contacts in the Facebook timeline. Then, *SocialConnector* filters this result and displays only the messages that were posted by people that are in the buddy list. This way, the user will not be able to see other Facebook interaction (e.g. “likes”, posts to other users’ walls). Finally, in the *photo display* channel, the system only displays the pictures that are not published by Facebook contacts that are contained in the buddy list.

4.6. Automatic user authentication settings

The system is designed to authenticate users without using credentials in any of the communication tools that are integrated to it. In order to accomplish this process, there are settings that have to be configured before the first use of SocialConnector. The configuration of these settings and the first use of SocialConnector should be done by the community administrator.

In the case of *videoconference*, Skype has to be installed in the device, and the synchronization of contacts between the application and the device must be active. After the first use of this application, the device will record the credentials. This will allow SocialConnector to get the Skype contact list and start a *videoconference*.

In the case of *private messages*, a Gmail account must be set up in the device. SocialConnector will be able to get the username and an authentication token from the device to log in using the open standard authorization protocol OAuth 2.0. Then, it can send emails using the mail transfer protocol SMTP, and also receive emails using the message access protocol IMAP.

In the case of *public messages* and the *photo display*, the Facebook client has to be installed in the device. After the first use of this application, it will remember the credentials. The SocialConnector system will ask to install a Facebook application and to grant

permissions that will allow the system to read and write content using the Facebook Platform Graph API and the Facebook Query Language. If the user does not install the Facebook application, the system will not show the main user interface.

5. System evaluation

The usability and usefulness of the new system implementation was evaluated involving nine older adults (age: 61–89, M: 73.8, S.D.: 9.1), where six of them were women. Most participants did not know how to use a computer, and they usually perform social interactions through wired phone and face-to-face meetings. Half of the participants used mobile phones and knew how to exchange text messages. Two participants knew how to send emails and one of them was a regular user of Facebook.

For the evaluation process we used paper prototyping [32] and the thinking aloud method. The prototype involved eleven screenshots organized according to the four services shown in Fig. 4. The first step in this evaluation process was to explain the main goal of the application, its main components and the way in which the application should be used. Then, we requested each participant to complete four tasks following various interim steps. An assistant recorded the time spent in each task, and the number and a description of the errors committed by the participants. The assistant also supported the elders when they were in trouble, without providing direct answers to their questions.

After completing the required tasks, the assistant conducted a short interview to get the participants’ impressions, doubts and criticisms. Table 1 summarizes the tasks performed by the participants and the obtained results. Then, we present and discuss the feelings of the participants about the usability and usefulness of this application.

The first result that we can highlight is the fact that all participants were able to complete the assigned tasks, although most of them never used a computer before. The time spent for completing the tasks was quite long; however if we consider the participant characteristics and also the fact that they were using the system for the first time, these times becomes highly promising, since the typical learning effect should contribute to reduce them.

Concerning the number of errors made by the participants, the email service (private messages—Task 2) seems to be the most difficult feature for the users. It was probably because that service involves interacting through the touchscreen and with voice messages, which was not easy to understand for the elders. As two older adults stated during the evaluation process, the metaphors used to represent the list of contacts and messages were not clear for them.

OA’1⁵: “Can I use those arrows to change messages or to change contacts?”.

OA’3: “Why do I have to talk to the computers?” Did it understand what I’m saying?”.

If we consider the results of using the public messages service (Task 3, performed immediately after Task 2), we can see that the spent time and number of errors involved in that activity decrease considerably, probably because of a learning effect. This means that the periodic use of these services would turn its usage easier for elders. The last assignment (Task 4, watching photos of family members) was the most motivating task for the elders and also was the task where the participants made fewer errors.

The age of the participants and their level of technology adoption seem to affect the spent time and number of errors involved in the use of SocialConnector. However, these limitations could be

⁵ OA’= older adult participating in the evaluation process.

Table 1
Summary of the evaluation results.

Assigned task	Avg. time spent (min)	Std. Dev.	Avg. number of errors	Std. Dev.
1. Initiate a call with a family member (using Skype) a. Choose the correct icon for launching the service b. Choose the correct contact c. Launch communication	3.2	2.6	0.6	0.7
2. Send a private message (email) to a family member a. Choose the correct icon for launching the service b. Choose the correct contact c. Compose the message d. Send the message	4.6	1.8	4.1	2.0
3. Send a public message (Facebook message) to a family member a. Choose the correct icon for launching the service b. Choose the correct contact c. Compose the message d. Send the message	3.3	1.7	1.2	1.0
4. View the photos sent from a family member a. Choose the correct icon for launching the service b. Choose the correct contact c. Swap between photos	2.1	1.3	1.0	0.9

overcome with a short instruction period. Moreover, the participants asked many questions to the assistant, showing that they were afraid of making mistakes. Therefore, self-confidence in the use of the application will also contribute to reduce times and quantity of errors when using the application.

Concerning the interviews performed after the tests, most participants were highly enthusiastic of using the system. They perceived the application usable and useful, however they were not able to identify the particular advantages that the application provides them for interacting with other family members. Probably the regular use of the system would allow them to be aware of these advantages.

OA'3: *"I like the system and it seems to be useful for me, but I still do not know how to take advantage of it"... "I should use it [the system] for a while to see its advantages"*.

The participants indicated several issues in the design of the user interface that should be revised in order to make them more intuitive for the intended target group. For instance, they did not understand the goal of using public messages. It seems that elders do not recognize such a concept; therefore that service could be removed. However, before doing it, we have to verify that this preliminary finding is representative for most elders.

OA'5: *"At this age I would only use the phone and the mail button to get in touch with others"*.

OA'6: *"I would prefer to send a private message to someone that I know that will tell the others than to send a public message"*.

The usage of the contact list was other element that was not intuitive for them; however, once the assistant explained again how to use it, the participants understood.

OA'4: *"At the end, I understood how to use the system (...) I think that I could use it alone [without assistance]"*.

The combination of using touch and voice interaction for sending messages was other aspect somewhat confusing for the participants. This issue could be addressed using a voice guide that indicates to users the next step to follow. The meaning of some icons, such as the pencil for writing messages or the F for accessing Facebook messages, was not intuitive for elders.

OA'5: *"Does this 'F' stand for Facebook? I do not understand things like Facebook"*.

OA'7: *"I know that people communicate using Facebook, send messages, but I do not use it, I do not know how to use it"*.

Although the evaluation results show the application still has space for improvements, the most important aspect to highlight is

the fact that the participants were able to accomplish the assigned tasks and were engaged and eager during the activity. This leads us to expect more interesting results for the next version of this system.

6. Discussion

This section presents a discussion on the design decisions we made to address the communication asymmetry created by the existing differences in media preferences and routine patterns among family members, and the evaluation of an intuitive interface for older adults.

Although the presented evaluation shows promising results, more research is needed to understand the communication routines and media preference among older adults and their families. Prior work has emphasized the impact of loneliness or isolation in older adults, affecting their cognitive and physical health [33]. Although new technology facilitates social interaction between people [34], research has shown how older adults are reluctant to adopt new technologies [35], increasing the communication gap between generations. Within the HCI community, efforts to connect older adults and their relatives have made through interactive design [36,37]. Nevertheless, current efforts have aimed to deploy communication systems in each household of the family members. This creates the inherent problem where young adults have to add use another communication media. Our approach differs from prior research since we propose to have a tablet application for older adults, that mediates communication among multiple communication media services to help older adults to stay in touch with their relatives.

SocialConnector integrates and simplifies four services into an intuitive interface for older adults. Our results indicate that SocialConnector contributes to the research efforts of making existing communication technologies easier to interact [38,39]. Older adults indicated that SocialConnector is easy to use and they are willing to adopt the technology due to its natural interface based on gestures, voice and icons. However, simplifying the interfaces of three communication services (i.e. Skype, Facebook and email) with pictorial icons created some uncertainty of how to use the system. As suggested by [40,41], our findings also suggest that pictorial icons should be properly labeled to ensure they convey what they are intended to do. Occasionally, older adults misunderstood

the purpose of the icons, but these misinterpretations did not discourage them from adopting the system as they perceived the significant value of staying in touch with their relatives.

OA'4: *"I am really happy to learn using Internet (...) I feel that this system will help me to be more in touch with my children and grandchildren"*.

We leave open for future work the design and development of context-aware services that automatically identify the communication practices of the contacts of the older adult. Automatically identifying these communications practices opens the opportunity of automatically selecting the best communication media in the back end but using a single interface for the older adult.

Of course, understanding communication patterns and rhythms of relatives is a broader problem where smart algorithms should take into account numerous of conditions to determine a proper moment to initiate a social interaction or enforce privacy concerns. Nevertheless, the SocialConnector implementation demonstrates the feasibility of developing an architecture to manage a set of popular communication services with an I/O service interface, and provide a cleaner interface for the older adult with means to communicate either asynchronously or synchronously with their peers. By providing both types of communication, older adults and relatives avoid routine or time zones limitations, and can stay in touch despite the media preference and the rhythms of their lifestyle. Studies have shown how synchronous communication services (i.e. video call) provide a heavyweight mean of communication to support dedicated social interactions, exchange complex themes, and eventually foster a sense of presence and connectedness among participants [19]. SocialConnector facilitated this type of interaction through its availability indicators, encouraging older adults to call their relatives and initiate social interactions with a certain degree of confidence that their relatives would reply back.

OA'1: *"If SocialConnector rings as a telephone, I would definitely use it for contacting my relatives"*.

Ultimately, communication systems must take into account that older adults do not wish to be burdensome or intrusive [11], in contrast, systems should invite older adults to initiate contact or provide reassurance that their relatives are fine [6]. Moreover, older adults were pleased with the asynchronous channels in SocialConnector. Other studies suggest differently, where their findings indicate older adults felt pressured to reply back, causing a sense of degradation in the communication. However, during the evaluation of SocialConnector, older adults indicated that having these asynchronous channels of communication allows both parties to respond when it seemed appropriate. Furthermore, as suggested by Riche and Mackay [16], some forms of communication do not involve explicit sharing of messages. Our results suggest that older adults appreciate subtle ways of social awareness in the form of photos because they provide implicit information about their relatives.

OA'1: *"I liked the photos (...) By watching them, I feel like they are always by my side and I enjoy remembering those moments"*.

OA'4: *"I really loved [to navigate through] the photos of my children and grandchildren"*.

Surely, the way in which older adults interpret the photos plays an important role on how the older adult builds a perception of their relatives or how it supports their social relationships. Nevertheless, the inclusion of social media should be investigated since older adults value better to know about family members' life rather than sharing their own life events [6].

Finally, we acknowledge that paper prototyping is not reliable enough to simulate the performance of SocialConnector; however, this evaluation method allowed us to detect usability problems in early stages of the design, and older adults were involved from the early stages of the design process. In addition, because a form of user engagement involves participants comparing the evaluated

prototype against other successful technologies [42], we can argue that the design ideas and results of the SocialConnector suggest that this design might engage older adults in social communication.

OA'1: *"If I am sure that my relatives are available, I will use SocialConnector to call them"*.

OA'4: *"I would really like to learn how to use in depth the system. Does it work like SMS, right?"*.

OA'5: *"I am eager to learn how to socially interact with my family in this way, since we are less disruptive"*.

Open questions remain to understand keen aspects of social relationships (e.g. reciprocity) and asymmetries during a long-term evaluation after the novelty aspects of using such application wear off. As indicated by Lindley et al. [6], asymmetries are inherent in relationships and are expected between older adults and relatives. Therefore, it is of our interest to further understand the impact of designing dedicated interfaces for older adults that might alleviate existing asymmetries in traditional interfaces used by the younger generations. Lastly, privacy concerns might arise with in the use of the technology that incorporates social media resources.

7. Conclusions and future work

This article presented a study that evidences a communication asymmetry between older adults and their relatives. This asymmetry is produced mainly due to both, the lack of balance in the social media preferred by family members, and the eventual mismatch between interaction rhythms that these people have to perform social interactions. Reducing this asymmetry is particularly relevant for older adults because it helps reduce their social isolation, which affects their physical and mental health. Trying to contribute to address this challenge, we used the results from a user study to redesign the SocialConnector system, a software application that aims at connecting older adults with their relatives.

The new version of the system integrates several social media services that are provided through the cloud in order to address an important part of the stated communication asymmetry. For instance, the new system allows family members (particularly young people and adults) to specify their preferences about the communication channels to be used to contact them. A message content translation process makes possible the social interactions among users of different tools. This service tends to increase the social interaction flow from and towards the older adults, since the effort for socializing is now fewer than in the previous version of the system.

SocialConnector also provides presence awareness (user availability) to support synchronous interactions. These new capabilities allowed us to address, in various interaction scenarios, the requirements identified in presented study. Particularly we can address urgent messages and also the sending of low-priority information by elders when they are not sure about the availability of the target person.

The results of a preliminary qualitative evaluation indicate that the system is usable and useful for elders. Although there are various aspects of the user interface that should be improved, all participants were able to complete a set of assigned tasks and they were eagerly engaged in the process. This is an important and promising result if we consider that the participants were not users of computer systems. However, a long-term summative evaluation using the real software system is still required to identify the overall user experience of SocialConnector. Such an activity is part of the next steps. In addition, we plan to integrate in the system a service to provide availability and presence awareness through ambient monitoring. These services can be implemented through smart objects; for instance, using the eBowl [31] that uses the RFID tag in the

keychain of the older adult to infer that the user is at home, or u-Pillbox [43] that helps elders to follow their medication regimens. These smart objects not only support elders, but also keep accordingly informed to the elders' social network. Similarly, the system could detect if the person is watching TV, taking a bath or cooking, and based on that indicates the availability to the relatives.

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Diego Muñoz is a M.Sc student of the Computer Science Department at the University of Chile. He received a Bachelor degree in Computer Science from the same University in 2013. His research interests include mobile and ubiquitous computing, human–computer interaction and healthcare. He has been working as research assistant in the mobile collaboration and ubiquitous computing group of the University of Chile during the last two years, and he has done research stays at CICESE, Mexico and University College London, England.



Jesús Favela is a professor of computer science at CICESE, Mexico, where he leads the Mobile and Ubiquitous Healthcare Laboratory. His research interests include ubiquitous computing, medical informatics and human–computer interaction. He holds a B.Sc degree from the Universidad Nacional Autónoma de México (UNAM) and M.Sc degree and Ph.D from the Massachusetts Institute of Technology (MIT). He is a member of the ACM and of the Sociedad Mexicana de Ciencia de la Computación, of which he is former president (SMCC).



Raymundo Cornejo is a postdoc in the department of Communication Studies at Northwestern University. His research interests include the design, development and deployment of ambient social prototypes to connect older adults with their families, and investigate how this technology impacts family ambient awareness, perceived identity, off-line encounters, wellness and isolation. His overall research goal is to understand how augmented technology and social media empower everyday human activities with special emphasis on the elderly. He holds a Ph.D. in Computer Science, M.S. in Computer Science from

CICESE, and Engineering degree in Computer and Information Systems from ITLP.



Sergio F. Ochoa is an associate professor of Computer Science at the University of Chile. He received his Ph.D. in Computer Science from the Catholic University of Chile. His research interests include computer-supported collaborative work, software engineering, mobile and ubiquitous computing, and educational technology. Dr. Ochoa is member of IEEE, ACM and the Chilean Computer Society and sits on the Steering Committee of the LACCIR (Latin American and Caribbean Collaborative ITC Research Initiative). He has worked as a software engineer for more than ten years and he currently serves as an IT consultant for a

number of public and private organizations in Chile.



Francisco Gutierrez is a Ph.D. candidate in computer science at the University of Chile. His research interests include human and social factors in computing systems, social computing, computer-mediated communication, mobile and ubiquitous computing, and computer science education. He is a student member of ACM, and of the ACM Special Interest Group on Computer–Human Interaction (SIGCHI).



Mónica Tentori is an assistant professor in the department of computer science at CICESE. Her research intersecting human–computer interaction and ubiquitous computing particularly focuses on designing, developing, and evaluating natural user interfaces, self-reflection capture tools, and new interaction models for ubiquitous computing. Her work is being applied to healthcare and urban living to support the needs of urban citizens, hospital workers, elders, and individuals with autism. Monica Tentori received Microsoft Fellowship in 2013 for her research work.