An Exploratory Study of a Touch-based Gestural Interface for Elderly

Chiara Leonardi, Adriano Albertini, Fabio Pianesi, Massimo Zancanaro
FBK-irst
Via Sommarive, 18 38050 Povo Trento, Italy
{cleonardi, albertini, pianesi, zancana}@fbk.eu

ABSTRACT
This paper presents the design ideas and a preliminary study of a touch-based gestural interface to support older adults in social networking. We had the hypothesis that the directness of gestures made them well suited to implement an interaction metaphor based on familiarity. Although preliminary, this hypothesis can be sustained. In particular, we found that most of the gestures (and in particular the iconic and the dynamic ones) have a hedonic quality that attracted and motivated our participants. We think that our results may contribute to the ongoing debate about gestural interfaces and help in understanding the value and the issue of this form of interaction.

Author Keywords
Elderly, gestural interfaces, touch-based interfaces, familiarity-based design.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
The progressive aging of world population has important social and economical consequences. Focusing on health, long term care and social services, ICT have a great potential in developing solutions that improve older people's safety, security, active engagement in society, happiness, self-confidence and, in more general terms, independence [9].

At the same time, despite their willingness to learn how to use a computer, most older people still regard technology as something not belonging to their own world, feeling uncomfortable and anxious about it [16].

The consensus is wide that the main reason for those negative feelings is that both the available hardware and software, and in particular the interfaces, have never been designed to suit older people's needs, skills and interests [2]. The results are the mentioned sense of unfamiliarity, anxiety and lack of engagement: even when the perception is clear of the potential of ICT technology for her life, an older person might well consider the needed investment of personal resources too high and not worth the trouble [9].

In order to address those problems, we have exploited the notion of familiar design [17] to realize an embedded device with a touch-screen-based interface to support older adults in keeping and nurturing their social networks.

In this work, we briefly summarize the participatory design process that lead to the current choice of functionalities as well as the design concept of the interface; we then illustrate the basic functioning of the interface and finally discuss the lessons learned from initial user studies conducted in a town located in the north-east of Italy.

RELATED WORK
Studies considering computer use by older adults have received an increasing attention in recent time [18]. Turner and Van de Walle [17] report that the difficulties in using new technologies can be motivated by older people's perception of being too busy or too old to learn to use them and by their more general feeling of alienation toward the digital world.

Anxiety and negative emotional reactions when making errors should also be considered: Lagana et al. [7] focused on the relationship between age, computer anxiety, and performance on computer tasks and showed that older people had significantly higher computer anxiety than younger adults but that computer anxiety was unrelated to performance. Selwyn [14] observed that older adults' ambivalence with respect to ICT originates from a limited perceived relevance for their daily life. According to Segrist [13], the negative attitude towards the computer is modifiable; in particular, meaningful computer training influences older people's attitudes.

Growing attention has been recently paid to investigating whether and how touch interfaces can promote the usage of ICT by older people, with several studies suggesting that gestures performed through fingers on a touchable surface (rather than using the mouse) can indeed provide important advantages. Especially with novice users, gestural interaction provides for easier and more enjoyable learning

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and remembering [4], while encouraging play and exploration [12]. Jacob et al. [6], in turn, emphasize that grounding interaction on the real world can reduce mental effort and support learnability thanks to the users' reliance of everyday skills in the process of sense-making. Murata et al. [10] argue that, in comparison with a traditional mouse and keyboard setup, the touch panel has the advantage of simplicity and offers opportunities to design more accessible systems. The study performed by Siek et al. [15] addressed touch-based PDA usage by older people and their performance in the lights of their reduced vision, dexterity, and coordination skills; their findings suggest that older adults can physically interact with PDAs as profitably as younger people.

On the other hand, in a recent provocative paper Donald Norman [11] identifies a number of challenges gestural interfaces must cope with, among which he mentions the lack of feedback and the lack of support for discovering system functionalities. He argues that since gestures are unconstrained, they are prone to be performed in an ambiguous or uninterruptable manner; in this case, constructive feedback is required to allow the person to learn the appropriate manner of performance and to understand what went wrong with her actions.

Current applications and products for older people typically deal with accessibility but they often fail on familiarity. For instance, a web site built to be accessible is surely more readable and simpler, but remains an artifact distant from the culture and knowledge of a senior person.

A familiar technology is something that the user is equipped to approach on the base of a shared background of concepts, meanings and practices that are not conscious or intended but are rather present in a non prominent way [17]. The focus should therefore be broaden moving from the usual notion of "interacting with" to "being-with" technology, under the assumption that "technology does not simply make tasks more efficient, it changes the underlying human practice" [16].

Our design work explores further the concept of familiarity by putting it into practice in the design and evaluation of a gesture-based touch-screen interface embedded in a movable device intended to support seniors' social inclusion

THE DESIGN OF THE MOBITABLE

A group of 26 senior citizens aging 65 to 93 (19 women and 7 men) was involved in the research. We first explored their quality of life, their domestic and social routines, and the way they experience the challenge of living independently. Attention was paid to their attitudes toward ICT, their use of communication devices and the way those devices sustain, or fail to sustain, social relationships.

Involving elderly people in research studies raises specific challenges [3], to circumvent which different alternative methods were employed in our study, balancing their respective pros and cons.

Contextual inquiries and focus groups were employed during the initial stages to gather information about lifestyles and people practices concerning managing their social network. At later stages, scenario-based design concepts were evaluated in scenarios-based workshops with our participants. In this phase, we tried to assess both the appropriateness of the functionalities selected and the constraints on the form factor of the device, doing our best not to present the device as a computer.

Figure 1. Formative evaluation of a vertical prototype

Finally, we engaged in few interactive cycles of rapid prototyping and formative evaluation to finalize the design of the system (see figure 1).

The entire process is fully described in [8]

THE MOBITABLE

The MobiTable (see figure 2) is a gestural touch-based interface embedded in a movable device which resembles a portable table. It is equipped with a resistive touchscreen (which can be operated by means of a pen or of a finger), a webcam, a wifi connection and an optional wireless keyboard.

Touch is the main input modality and manipulative gestures the primary interaction mode.

The cultural characteristics of our target users were addressed by exploiting familiarity-based metaphors to communicate the meaning of functionalities and animations and support awareness of synchronous and asynchronous events.

The Public Square is an asynchronous communication tool for sharing user-generated contents within larger peer groups. It is based on the metaphor of the square where members of the local community physically meet to share knowledge and participate in social activities.

Figure 2. The current version of the MobiTable

The Public Square allows the asynchronous sharing of multimedia contents within the member of the community. Messages can be created by first drawing with a finger a rectangular- or square-like frame on the background of the Public Square and then entering text by means of either the optional keyboard, the finger or a stylus. To send it and make available to other people, the user simply needs to drag it into the topic boxes.

Figure 3. The Social Area (left) and a participants writing a postcard with the pen on the touchscreen.

The Social Area (Figure 3) includes a synchronous video-communication tool and a email-like functionality to exchange written messages– called Postcards – with friends and family members. A scrollable list of house-shaped icons representing the user's virtual neighbourhood is available on the top of the screen. Video calls can be activated by tapping over one of the houses. Postcards are created in a way similar to that described for the Public Square's messages, and sent by dragging them on the recipient's house.

A Shared Calendar to schedule personal appointments and group activities is also made available. It consists of a repository of text messages and pictures that can be uploaded and downloaded by the members of the community.

A chest of drawers is made available as a tool for storing postcards and images

The space on the interface has been organized taking inspiration from the ZUI paradigm (Zoomable User Interfaces [1]): every objects available in the system is always accessible on the screen. Tapping on an object enlarges it and shrinks the other objects. For example, to move from the Social Area to the Public Space, the user simply needs to tap on the shrank box of the Public Space; the latter will be enlarged by means a slow animation while the Social Area will be shrank in a similar way.

A PRELIMINARY USER STUDY

A study was designed and conducted on 15 older people using the MobiTable at a local senior center.

The ages of the subjects ranged from 62 to 93 (average 77). For all but one, the educational level was limited to compulsory education. Only two of them had some previous experience with computers (mainly word processing and email) and a positive attitude toward technology; for all the others, computer anxiety was very high.

Each subject participated in 2 to 4 individual or paired sessions in which they were instructed about the different functionalities of the device and left free to experiment with it.

All the sessions were video-recorded and the analyzed through a qualitative approach: problems were annotated and then clustered along emerging dimensions.

The study targeted our two major design hypotheses: that the directness of gestures made them well suited to support familiarity-based interaction and that the dynamic nature of gesturing was an useful complement to the pervasive use of animations and to the zooming approach to space management.

This study was a pilot for another study that involved a subset of the subjects in using the MobiTable in their home setting for four months. The data from the latter study are still under analysis.

ANALYSIS AND DISCUSSION

Despite initial difficulties in grasping the idea of accomplishing actions by directly interacting with digital objects, our participants quickly mastered the basic notions of the interface and the mechanics of the gestures, with a few exceptions discussed below.

Touching and gesturing

In general, the participants changed from an initial strong preference for the use of the pen/stylus (possibly due to the "fat finger" effect [15]) to a slight preference for the finger as they became more comfortable with the device. They continued to use the pen/stylus for interacting with small targets

The tap gesture

Tapping on the screen to activate objects was understood pretty soon but some participants, especially the older ones, had a persistent problem in timing the gesture. In our implementation a "tap" was defined as a touch gesture consisting of a precise and quick succession of "press" and "release". In some cases, we could measure up to one second long lags between the "press" and the "release" components. In other cases the finger slightly moved while still being in the "press" state, tricking the system into interpreting the whole as a drag gesture.

A more critical issue emerged when the tap gesture had to be applied on the background in order to "close" an action (for example, after the writing of a postcard, the user has to tap on the background in order to put it into an envelope and prepare it for sending, see figure 4). This usage of the tap gesture raised many problems and misunderstandings. Almost all of our participants experienced difficulties in remembering it even after repeated explanations. Several (but not all) of them resorted to the effective strategy of identifying a specific area of the background where to tap. A possible explanation for these problems may be that our participants failed to conceive of the background as a meaningful place where to gesture in order to act on an object.

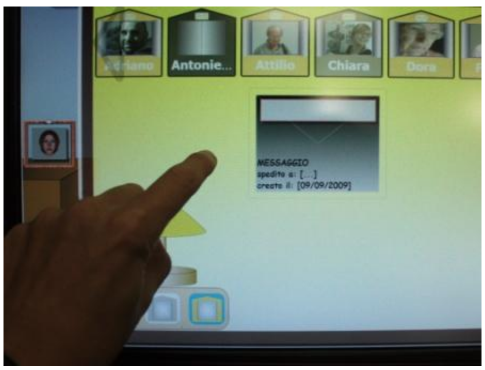

Figure 4. Tap outside (on the background) puts the postcard into an envelope before sending it.

Dragging objects around

Dragging an object to a particular place in order to trigger an action was not so easy to understand despite its apparent resemblance with familiar actions (such as posting a mail by bringing it to the mailbox). Several participants had problems in remembering that in order to send a postcard they have to drag it (or put it) onto the corresponding receiver's box. Some participants started drag actions but were then unsure as to how to complete them. Others were more comfortable with the "touch to trigger" scheme and tried to activate the sending procedure by touching the receiver's box. These problems may be due to the lack of cues and affordances for drag-and-drop: it is not always obvious that an item can be dragged and where it can be dragged to.

Drag gestures also gave raise to a problem that was the reverse of the already mentioned tap→drag mis-interpretation and consisting in intended drag gestures that the system mistook as taps because the finger was lift from the surface before starting the movement

Unsure touches and lack of resolute pressure were the main cause of problems for both tap and drag gestures. In particular, dragging needs a constant pressure for the whole duration of the operation and some participants with dexterity problems due to age or age-related pathologies found this requirement very demanding. This problem was particularly pernicious given that our implementation used the common assumption that when a drag is interrupted the object is automatically re-positioned at its initial place. This may help the user because the interface automatically goes back to the initial, and therefore recognizable, state; for our subjects, however, this was simply a violation of the "natural" law that objects remain wherever they are left.

Iconic gestures

Iconic gestures are those gestures that visually and analogically represent their meaning.

In our interface, we have just the gesture of drawing a square to create a new message (like a postcard in the Social Area) as an example of an iconic gesture. All the participants understood it quite well, in spite of the rigidity of our algorithm that required accurate drawing of the angles for recognition. Since our algorithm worked also when half of a square perimeter was drawn (through a sort of gestalt-like completion), several participants preferred to referred to it as "the L gesture". In this way, they moved away from the memory value of the iconicity to rely on an "operational" definition that makes gesture performance easier.

The feeling of being able to create digital objects through physical actions made the L-gesture a crucial factor in motivating our subjects at the initial stages and in stimulating an exploratory attitude towards the interface.

Finally, it is worth noting, that nobody had problems in drawing this gesture on the background (as for the "tap out" gesture). A possible explanation is that in this case the gesture was used to create an object and therefore gesturing on the background (the place where the object will be created) was considered natural.

Flicking, scratching and drawing lines

Flicking gestures were used to scroll lists (such as the contact list). Scratching and line-drawing were used to delete text inside a postcard or a note and to delete an entire object (such as a postcard or a note) respectively.

As with the L-gesture, these three gestures surprised and pleased because they look "magical". Almost nobody had problems in understanding and remembering it.

Some participants experienced execution problems with these gestures, similar to those described for dragging. Recovery was easier in this case due to their simpler, one-step nature.

With flicking, some participants experienced problems in calibrating the correct execution speed, producing initial hesitations that the system interpreted as a tap action with unintended consequences (e.g., selecting and opening a message instead of the scrolling a list).

The difference between scratching (several back and forth line-drawings executed in a rapid sequence) and line-drawing (the stroke of a single line) proved to be very effective in avoiding the unintended deletion of a postcard while trying to just delete a word inside it. All participants were able to understand the difference.

Due to the rigidity of our recognition algorithm, the line had to be perfectly straight and in scratching each component line had to have exactly the same orientation. As a consequence, the scratch gesture was more easily performed through the pen than through the finger; all the participants quickly adapted without complains.

Animations and zooming

Animation are constantly used in our interface with the aim of helping the user in noticing and understanding both system's responses (e.g., the automatic storing of a copy of a sent postcard into the drawer) and asynchronous events (e.g., the reception of a postcard). Although we do not have a systematic experimental setting to prove it formally, our observations tend to suggest that animations alone are not enough to actually make the users aware of the system status.

We also implemented a contextual help by means of a talking head that informs the user about synchronous and asynchronous events. Initially, it was designed as an optional support for the more naive users; it eventually turned out that the presence of the talking head reinforced animations that would otherwise go unnoticed. This is consistent with what reported by [5].

Finally, all participants found the usage of zooming to access the various areas easy and intuitive. The closure of an area without opening a new one was a problem since it was implemented by a tap-out gesture that, as explained above, was very difficult to understand for almost all our participants. Actually, the necessity of closing an area without opening a new one was expressed by few participants only.

LESSON LEARNED

Putting all our observations together, we can draw the following guidelines for the design of gestural interfaces for older people: (1) tap gestures (when applied to well recognized objects) are the easiest ones to understand and remember. The definition of the tap (for example, how much time is allowed between touch and release) should be carefully considered and possibly automatically adapted. (2) Tapping on the background outside of an object to perform some actions on that very object sounded unintuitive and should be avoided. The idea of "tap on nothing" (that is, on the background) is very difficult to communicate; (3) do not overload the same object with actions performed by a tap and by a drag gesture because in case of insufficient pressure or of false starts the two gestures may be easily confused; (4) for drag gestures, the "natural" version should be implemented: when the touch is lost during a drag the object should stay where it has been left rather than flying back to its initial position. (5) iconic gestures are very engaging and their hedonic value should not be underestimated as a way to motivate users with high computer anxiety; (6) a proper setting of the time parameters of gestures is of paramount importance. In this respect, the possibility of automatic adaptation by the system should be seriously considered because of the large variability in touch performance by elderly people (due to age, health-related issue, etc.). (7) Animations alone are not effective in signaling synchronous and asynchronous events on the interfaces and should be accompanied by redundant information in other modalities.

CONCLUSIONS

In this paper, we briefly introduced a new tabletop device with a touch-based gestural interface to support elderly in communicating with their social network. We mainly focused on the interaction paradigm and in particular on the role gestures have in realizing a familiarity-based approach to design.

We think that our results may contribute to the ongoing debate about gestural interfaces [see for example, 11 and 12] and help to understand the value and the issue of this form of interaction.

REFERENCES

1. Bederson The Promise of Zoomable Interfaces. In Proceedings of CHI2009. Boston, April 2009.
2. Bucar and Kwon Computer Hardware and Software Interfaces: Why the Elderly Are Under-Represented as Computer Users. *CyberPsychology & Behavior* 2(6), 535-543
3. Eisma, R., Dickinson, A., Goodman, J., Syme, A., Tiwari, L., Newell A. F. Early user involvement in the development of information technology related products for older people. International Journal Universal Access in the Information Society, 3, 2 (2004), pp.131-140.
4. Hollinworth N., Improving Computer Interaction for Older Adults. SIGACCESS Newsletter (93), Jan 2009:1117
5. Jacko, J.A., Scott I.U, Sainfort, F., Moloney, K.P., Kongnakorn, T., Zorich B.S., and Emery, V. K. Effects of Multimodal Feedback on the Performance of Older Adults with Normal and Impaired Vision. In N. Carbonell, C. Stephanidis (Eds.): User Interfaces for All, LNCS 2615, pp. 3–22, 2003.
6. Jacob, R. J., Girouard, A., Hirshfield, L. M., Horn, M. S., Shaer, O., Solovey, E. T., and Zigelbaum, J. 2007. Reality-based interaction: unifying the new generation of interaction styles. In CHI '07 Extended Abstracts on Human Factors in Computing Systems.
7. Lagana K., Babcock R.L. Computer anxiety in young and older adults: Implications for human-computer interactions in older populations. In "Computers in Human Behavior", vol.13, n. 3, pp. 317-326, 1997.
8. Leonardi C., Mennecozzi C., Not C., Pianesi F., Zancanaro M. Designing a familiar technology for elderly

people. In *Proceedings of the 6th International Conference of the International Society for Gerontechnology, ISG'08*, June 2008, Pisa, Italy

9. Melenhorst, A.-S., Rogers W.A., Caylor E. C. The use of communication technologies by older adults: exploring the benefits from the user's perspective. Proc. Human Factors and Ergonomics Society, 2001.

10. Murata, A. and Iwase, H. 2005. Usability of touch-panel interfaces for older adults. Hum Factors. 47, 4, 767-776.

11. Norman, D. A. 2010. The way I see it: Natural user interfaces are not natural. interactions 17, 3 (May. 2010), 6-10.

12. Saffer, D. Designing Gestural Interfaces: Touchscreens and Interactive Devices. O'Reilly Media, 2008

13. Segrist, K 2004, 'Attitudes of older adults toward a computer training program', Educational Gerontology, vol. 30, pp. 563-571.

14. Selwyn N. Apart from technology: understanding people's non-use of information and communication technologies in everyday life . Technology in Society 25 (2003): 99–116

15. Siek, K., Rogers, Y. and Connelly, K. (2005) Fat finger worries: How older and younger users physically interact with PDAs. Proc. of INTERACT'05, Rome, September 2005.

16. Turner, P. Being-with: A study of familiarity. In Interacting with Computers, 20 (2008) 447-454

17. Turner, P. and Van De Walle, G. Familiarity As A Basis of Universal Design 2006, Journal of Gerontechnology. 5(3), 150-159.

18. Wagner N. Hassanein K. Head M. Computer use by older adults: A multi-disciplinary review. In Computers in Human Behavior. Vol.26 5, September 2010, pp. 870-882