Simplicity, consistency, universality and familiarity: applying 'SCUF' principles to technology for assisted living.

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Abstract. This paper describes the user interface design, and subsequent usability evaluation of assistive technology to support elderly and disabled people in their interaction with kitchen appliances in their homes. We have applied the four design principles of simplicity, consistency, universality and familiarity to a range of devices that can be used within the home environment. Our evaluations suggest that this approach has been successful.

Keywords: assisted living, usability, evaluation, design principles

1 Introduction

We have developed user interfaces situated in modified familiar home devices, specifically television sets, mobile devices and interactive digital photographic frames, as part of the EU FP6 IST EASYLINE+ project (Low Cost Advanced White Goods for a Longer Independent Life of Elderly People).

Sensors using radio frequency identification (RFID), ZigBee, powerline communication and infra-red technologies enable the EASYLINE+ system to interact with the home environment. Human activity is monitored by an intelligent server, which we call the *e-servant.* The e-servant recognizes and adapts to changing needs as the user grows less able over time.

A simple example of an EASYLINE+ interaction is the scenario of a cooker hob being left on either with no pan on it or after a pan has been removed. The message "Hob left on with no pan" is conveyed to the user (wherever they may be in the home). The precise nature of the interaction and the range of options available to the user are adaptive, flexible and dependent on their level of ability, which can be assessed on a number of scales. However, the essence of the dialogue in this case would be that the user could turn off the hob remotely or respond, "Yes, I know; leave it on" (if they are permitted to according to their profile). Other scenarios include "Food has expired in the fridge", "The washing cycle has finished", "This food cannot be microwaved", and so forth. Additionally, a standalone RFID reader advises the user what to do with an item of food or clothing, an innovation particularly useful for visually impaired people. To support the international dimension, a range of European languages is also supported.

Extensive testing of general principles and ranges of devices and interface designs took place in a purposely developed usability laboratory, which simulated an elderly/disabled person's living space.

2 User Interface Design

2.1 Devices

Interface devices implemented include the television, interactive digital photo frames (DPFs) and hand-held (or worn) mobile devices (MDs). The television was selected as the central point of control in the home, an observation corroborated by initial user surveys and the narrative workshops.

DPFs can be positioned in any room of the home for immediate notification (when not in use, they display conventional photos) and MDs can be used for emergencies and other forms of mobile interaction – in the garden, for example. It could be argued that MDs are not popular with the current generation of elderly people; however, this is changing quickly as such devices become more ubiquitous.

2.1 The SCUF Design Principles

The user interface design for EASYLINE+ needed to support a range of abilities but also conform to our proposed '*SCUF*' principles of *Simplicity, Consistency, Universality and Familiarity*. These principles informed the design of the device interaction based on the four colour (red, green, yellow and blue) buttons of a typical television remote-control (even on devices not associated with the TV such as DPFs and MDs), allowing for complete consistency of device appearance and operation.

2.2 Interface Modes

The EASYLINE+ interface exists in three modes:

- OFF: The system is inert. The TV is in stand-by or showing a programme, DPFs are in stand-by or displaying photos.
- DASHBOARD: At any point (and from anywhere in the house) the user can activate the system to view or change settings. For example: "What's in the fridge?", "How long until the oven has finished cooking?"
- INTERRUPT: The system needs to inform the user of some event; big (there is a fire) or small (the washing has finished). The system then behaves in accordance with user input – but also in line with the user profile (level of

physical or cognitive ability), which is driven by the e-servant via the e-servant controller.

An example of final interface design, maintaining adherence to the SCUF principles, is given in Figure 1.

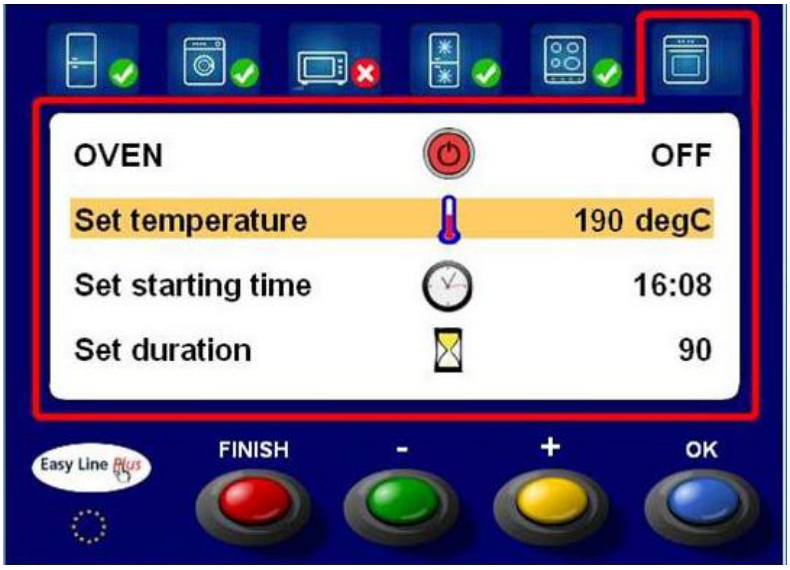

Fig. 1. Interface design screen example.

3 Usability Evaluation

We conducted between-groups laboratory-based usability studies with heterogeneous groups of users, including elderly and disabled users, people with learning difficulties, as well as with 'healthy' adults. We were interested in evaluating the latter group for two reasons. Firstly, it has been documented that elderly and vulnerable participants in usability studies may react differently than they normally would, for example by being over-positive due to their involvement in the study [1,2]. Comparing their results with what might be termed a control group would potentially identify issues of this nature. Secondly, our earlier evaluations suggested that the product might be suitable for time-impoverished people (for example, stressed parents with babies in the home), not just elderly and disabled people [3].

We selected a total of 27 participants for this evaluation exercise, comprising nine elderly users, nine with learning difficulties, and nine from the 'control' group. Each group was given a set of scenarios to follow (for example loading the refrigerator, baking food, and doing laundry), which involved interaction with the kitchen appliances and the user interface, which for this study was provided on a television screen and an MD. Participants' activities were recorded in the laboratory, and were subsequently analyzed. They were also asked to complete a usability experience questionnaire comprising 20 semantically-rated questions, which were categorized according to usability, design and layout, functionality, user satisfaction, and expected future use.

The aggregated results for every category and for all groups indicated a positive outcome for the usability experience questionnaire. An Analysis of Variance (ANOVA) revealed that there were no significant differences in the responses provided by the three groups ($F = 1.52$; $p < 0.05$), apart from one question which asked whether they felt embarrassment at using the system - some members of the learning difficulties group were uncomfortable with it from this point of view. The control group performed expectedly better in general, and the only observed usability issues involved elderly users' difficulty in using a standard remote control handset and the small-screened MD, both of which were easily rectified by selecting alternative input and output devices.

4 Conclusion

It is very well-documented that we are experiencing an increase in the number of elderly people and a reduction of younger people to care for them as they lose their independence in later years. Our evaluation of the EASYLINE+ project suggests that it has made a small but valuable contribution towards helping elderly and disabled people remain independently in their own homes for longer, something that is popular with those people, as well as potentially tempering future increases in elderly healthcare spending.

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