Proceedings Paper:
Judge, Simon and Blackburn, Steven (2008) The use of eye-gaze data in the evaluation of assistive technology software for older people. In: Istance, Howell, Štvep'ankov'a, Olga and Bates, Richard, (eds.) Proceedings of COGAIN 2008 - Communication, Environment and Mobility Control by Gaze. The 4th Conference on Communication by Gaze Interaction, 2nd -3rd September 2008, Prague, Czech Republic . COGAIN , pp. 67-72. ISBN 978-80-01-04151-2

The Use of Eye-Gaze Data in the Evaluation of Assistive Technology Software for Older People

Simon Judge
Barnsley Assistive Technology Team
Block 14, Barnsley District Hospital Foundation
Trust, Gawber Road. S75 2EP
Simon.judge@nhs.net
01226 432159

Steven Blackburn
Sheffield University, ACT Programme
ICOSS, Sheffield, S1 4DP
s.blackburn@sheffield.ac.uk
0114 222 6253

Keywords
Usability Study; Assistive Technology Software; Older People; Simplified Computer Access;

Abstract

This paper reports on recent work undertaking usability study of a software-based assistive technology. The software was developed to support increased opportunities and interactions for people in residential nursing homes and extra-care housing. The objective of the project was to allow older people and those with early onset of dementia to have access to some of the functionality of modern computers. The software could also have applications in other markets, such as schools and for older people living at home. The intention is to provide opportunities for active participation and facilitate more access to hobbies, interests, past-times and to develop and maintain social networks. The complex interface of modern computers otherwise often excludes people from access to digital media including video and internet telephony, games and activities, information and resources on the internet and other facilities that may be useful to them if presented in a different way.

The study presented is being carried out in 3 residential homes with 20 participants. Eye-gaze recording was a key element of the usability testing. The study methodology was designed to provide feedback towards the design of the software and to better understand the use of computers by this target group.

This paper presents the results of the first stage of the usability study, in particular the paper concentrates on the use of the eye-gaze data. The design of the sessions allowed participants to explore the system independently and then to complete some pre-defined tasks. The users' interaction with the computer was recorded through video, audio, screen and eye-gaze recording as well as a data-log of the physical and eye interaction. The process of acquiring eye-gaze data with this fairly non-typical cohort is examined and the value of this data in contributing to the design of this software is explored.

Introduction

The Advanced Care Technologies (ACT) Programme is a European funded venture to investigate the most effective applications of Assistive Technology and Telecare (ATT) to raise the quality of life for South Yorkshire's ageing population. A major theme of the ACT Programme is evaluation of the effectiveness and user acceptability of ATT products. It seeks to do this through collaborative partnerships between the university, industry and the health and social care systems.

The usability study described in this paper was conducted within the SIM WIN project. The SIM WIN project is an evaluation of an intuitive computer-based system developed for residents of residential care homes. The software was designed to provide enhanced accessibility to activities and interests, and

improve social interaction and networking to family and friends through videoconferencing facilities. The motivations behind the development of SIM WIN was to provide a means of mental stimulation, as an alternative (or complementary) to the traditional social activities existing in UK residential care homes. The University of Sheffield leads the SIM WIN project, in collaboration with Barnsley Hospital and a non-for-profit residential care home provider based in Sheffield, UK.

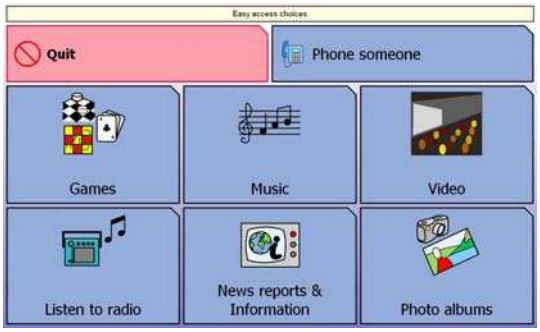

Fig 1. SIM WIN system (screenshot)

Eye-tracking or eye-gaze is a method of measure where people are looking while they perform particular tasks. Almost sixty years ago, Fitts, Jones and Milton pioneered the use of eye tracking (or eye-gaze) to assess the usability systems for airline pilots [Fitts, P. M., Jones, R. E., & Milton, J. L. (1950). Eye movements of aircraft pilots during instrument- landing approaches. Aeronautical Engineering Review 9(2), 24–29]. Since then, eye-gaze techniques has been used to assess a wide range of human-computer interactions., including military technology, menu-based software systems and website design. Literature concerning the implementation of eye-gaze techniques to assess the usability of software by older people is limited with only a few published studies, for example, Obrist et al (2007) used eye-gaze methods to investigate the usability an interactive TV application between a group of older people (50+) with a group of younger adults [Marianna Obrist, Regina Bernhaupt, Elke Beck and Manfred Tscheligi, Focusing on Elderly: An iTV Usability Evaluation Study with Eye-Tracking, Lecture Notes in Computer Science, Volume 4471: 66-75; 2007]

The aim of the study described in this paper was to evaluate the usability of the SIMWIN system, in addition the study aimed to investigate the role of eye gaze techniques as a tool for assessing the usability of computer-based systems developed for older people.

Study Design

The study is being carried out in 3 residential homes with 20 participants. Participants were a mix of day-centre attendees and residential home residents, all participants were not currently computer users and were aged 63 and above. The oldest participant was 96 years old. Participants had a range of associated medical conditions, including some functional and cognitive limitations. Recruitment was carried out by casual researchers through information sessions and demonstrations, inclusion criteria were diagnosis of dementia and any physical incapacity which would hinder the basic operation of the touchscreen (e.g. blindness).

Each participant undertook an initial usability session of approximately 20 minutes.The first half of the session allowed the participant to explore the system and during the second half the participant was asked to complete 6 tasks. The session was recorded using screen capture with eye-gaze data overlaid, video and audio capture and data-logging of mouse and gaze interactions.

Fig 2. Examples of recorded data

This session was followed by 3 months of regular training, personalisation and support sessions in the residential homes in a group environment. At the time of writing, this training period is ongoing and the first session of the usability testing has been studied and initially analysed. A follow-up stage of the study is planned to allow comparison of participant's use pre and post the training and support. The study methodology was designed in order to provide feedback towards the design of the software and to better understand the use of computers by this target group.

Analysis

A number of analysis stages are planned:

- Qualitative analysis of the recorded data (screen, eye, video and audio)
- Hand-coding of the recordings to analyse (tasks completed, task success rate, number of cells selected in each task)
- Quantitative analysis of the data-logged data (mouse and gaze interactions)

At the time of writing, the qualitative analysis has been completed and is briefly described below.

Preliminary Results

The qualitative analysis was conducted to identify and code themes within the data related to the usability of the system. Below is a brief summary of the main relevant themes.

Design Compromises and Features

Design compromises predominately emerged around the nature of the interface and making this less confusing for participants. A number of sub-themes emerged relating to 'confusability':

- The label used on the buttons: participants sometimes struggled to select 'correct' buttons in tasks, despite repeated prompting and having looked at the button. This may be related to the language and/or icon of the buttons not being relevant or understood by the participant.
- Not understanding the function of the button: some participants seemingly pressed buttons without fully understanding what the effect of pressing it would be.
- Not 'seeing' buttons: buttons on the system were sometimes represented in slightly different ways and in different positions. The eye gaze data showed that some participants, when trying to achieve a function, found it difficult to discriminate between different buttons in order to select the function. Several instances of 'not seeing' buttons – where participants' scan-paths showed that they had looked at a number of other buttons, but not the target one – where observed, particularly where target buttons were a different shape to the rest of the buttons and/or in the corners of the screen.

A few other sub-themes related directly to design considerations:

- Missing buttons: one specific part of the system, video playing, did not have a 'stop button' – a quarter of participants specifically noticed this design anomaly. In other comparable screens with a 'stop button' participants were easily able to identify and use the button, confirmed through observation of the eye-data.
- Content: in some parts of the system, participants can clearly been seen to understand the difference between the interface buttons and the content and also to demonstrate an expected cause and effect by looking to the content area after pressing a button. Analysis of the data also highlighted some areas of the system where participants did not seem to find it clear which areas of the screen were active buttons and which were displaying content.

Understanding and Cognitive Load

A number of themes emerged around participants understanding of the operation of the system, these themes can be broadly grouped into issues to do with navigation, the intuitiveness of interaction:

- Navigation:

Participants showed varying levels of understanding of the navigation: For example, there was evidence of confusion between the use of the 'Do something else' and 'Quit' buttons. However, some participants also showed good understanding of the concept of the 'Do something Else' button – frequently using it intentionally to choose another type of activity after having scanned and rejected the other options. Participants also showed varying abilities to understand the concept of the navigation between the levels in the system – most participants managed to show understanding of moving between the top level and second level to choose a specific activity. Eye gaze data showed that many participants actively scanned the available options on each level and then subsequently actively chose their preferred choice.

- Competence/intuitiveness:

Participants displayed varying levels of competence and intuitive understanding of the human-computer interaction. Many participants, during the first period of use of the system, showed an intuitive understanding of the touch-screen and how to use it, some other participants needed some instruction on the touch-screen, however they then learnt its operation. Some participants were also able to explore the system independently without prompting, including some of the more complex tasks in some cases, for example navigating through multiple levels to select preferred music tracks. For some participants, memory of the system sometimes appeared to affect their competence at using the system.

Discussion

Initial analysis of the data from the usability studies of this SIMWIN system software has shown it to provide a useful source of information for the design and study of this Assistive Technology software for older people. The recording of eye-gaze data has been demonstrated to be successful with this cohort which might have otherwise been considered challenging. Although it would have been possible to run the study without the eye data, the analysis has shown that combined with the other data streams (screen, audio, video) it provides a very rich source of data. A number of the themes that developed from the qualitative analysis of the data were reinforced through observation of the eye traces – for example, noting the eye track path across choices before a selection helped confirm that users were intentionally choosing options. Another example of the usefulness of the eye-data is shown in one of the themes where

participants appear to find it difficult to see one of the buttons – without the eye data, the reason for their difficulty in selecting this button would be difficult to induce.

The use of an eye-gaze system did have, however, some practical difficulties: for example, it was difficult or impossible to calibrate the system for some older people who wore quite thick spectacles. Also, the use of wheelchairs by some participants proved problematic when it came to locating the eye-gaze screen in front of them in the 'real environment' of a residential home.

Other forms of analysis of the data will take place to try to establish further information from the data; hand coding will help establish task success rates and times taken to complete tasks; and the data-log from the software will be analysed to see if this provides a useful information source. In parallel with this aspect of the project, a further study is being carried out to establish the cohort's opinions on the concept and use of this system.

Possible future research topics have already been identified – these include investigating specific aspects of interface use by this cohort – for example the relationship between content and buttons and optimal layout and positioning of these elements. The project is also likely to generate future research work regarding the use and accessibility of computers for older people.