

Improving Computer Interaction for Older Adults

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Abstract

A point and click interface can present difficulties for older adults (particularly those with physical impairments) who may not easily be able to operate a standard input device such as a mouse or trackball. The use of gestural commands, via a multitouch touchscreen device, is an alternative and direct method of interacting with an application. This research investigates whether gestural commands on a multitouch touchscreen device can make interfaces easier to use, learn and remember for older adults.

Introduction

It is estimated that by the year 2010, 17.6% of the population in the European Union will be over the age of 65, many of whom will undertake computer-based tasks for social, recreational, continuing employment or health-related purposes [9]. However, age-related studies [e.g. 6, 24, 25] have shown that interacting with a computer using traditional computer input devices, such as a keyboard and mouse, can cause problems for many older adults, in particular novices in this age group and those with age-related disabilities such as Parkinson's disease, arthritis and essential tremor. For example, difficulties can arise when attempting point and click interactions, such as drag and drop, which require manual dexterity and fine motor control. This could be improved significantly with touchscreen interaction, as it has the potential to offer more intuitive methods of interaction using existing skills, operating directly with objects, and requires less visuo-spatial coordination [24].

Existing research into touchscreen interaction [e.g. 15, 23] has relied mostly upon touchscreens that could detect only a single point of contact, which means that objects on the screen were manipulated directly using a single finger, and commands were invoked using single finger gestures, such as rubbing the finger from side to side to erase content or undo the last action. More recent developments in touchscreen technology offers the ability to detect multiple points of contact on the screen (e.g. all 10 fingers), allowing for the possibility of two-handed gestural interaction, such as simultaneous rotation and scaling of images, as an alternative to using a mouse.

This research aims to investigate how to design everyday computer activities for older adults, such as sending an email, by taking advantage of multitouch technologies. This will involve identifying the types of tasks and subtasks that are needed to undertake the given activity, and investigate how the tasks might be mapped to the touchscreen gestures. Previous research exercises [8, 23] have shown that there is variation in how people conceive of gestures for specific tasks. Hence, as a starting point the programme of work begins with an initial study (a 'paper and pencil' exercise) to gain a better understanding of what tasks are required for the given activity, the types of (two-handed) gestures used and how these differ between the younger and older age groups.

Related work

Background

Many studies have looked at the effects of ageing on computer interaction [e.g. 14, 19, 24, 25], and some have devised novel hardware and software techniques that could help improve interaction for both users with age-related declines and also disabled users [1, 21, 25, 28]. For example, techniques have been developed that help to steady the mouse pointer when making a selection [e.g. 21, 25] or make double-click actions easier to perform [e.g. 28]. However, these essentially aim to improve point and click interaction, using familiar (indirect) pointing devices, such as the computer mouse, which manipulate an on-screen pointer.

An alternative is to interact directly with on-screen objects using a touchscreen. For example, Potter et al [17] investigated three different methods of touchscreen interaction and compared the speed, accuracy and user satisfaction of each. They found that the method favoured by participants was to have the cursor located above the finger and offset from the finger location, rather than beneath the finger. Touchscreen accuracy was also studied by Benko et al [4] who developed a number of techniques to refine the accuracy of interaction, using a multitouch screen and two fingers, such as using the contact area of the finger tip to determine pressure. Other studies have compared the performance of touch screens with various other devices, and for a variety of applications. For instance, Karat [12] compared user performance and attitudes for menu selection using a keyboard, mouse and touch screen and found that keyboard and mouse performance were about equal, but less than the touchscreen.

Jin et al [11] investigated usability of icons by considering the optimal button size and spacing between buttons for touchscreen user interfaces used by older adults. Their experiments measured reaction time, accuracy and user preferences. Results showed that larger button sizes produced shorter reaction times, and was consistent with other studies such as Sun [20] who investigated button size and spacing for touchscreens used by fire-fighters and found that there is a trade-off between speed and accuracy that depends upon the spacing between buttons – larger spacing resulted in fewer errors but increased the reaction time.

However, the majority of work has been concerned with single point of contact devices. i.e. those limited to single touch interaction, often using just the index finger. More recent developments [e.g. 10, 22] can detect multiple points of contact using one or two hands, and allow for much richer interaction through gestures [e.g. 8, 14, 18]. Studies have looked at developing gesture sets and how they naturally map to computing tasks [8, 23], but these have so far been mostly for single handed interaction. Studies have yet to be conducted which consider two-handed multitouch gestural interaction and gestural interaction involving older users.

Interacting with Gestures

The operation of a device such as a desktop computer requires a rich set of gestures, since it needs to be able to activate a (potentially) large number of commands. Many studies have been undertaken that have investigated gestural input for computer interaction using devices such as touchpads and touch surfaces. For instance, gestural communication involves more muscles than keyboard or speech, so gestural commands

can be rather tiring to carry out in practice and therefore must be concise and quick, and not require high precision over a long period of time. Wu et al [26] considered this problem and developed a set of design principles for constructing multi-hand gestures that could be 'relaxed' after the initial contact with the surface, once the command had been recognized by the system. It included gestural reuse to reduce the number of gesture primitives that a user must learn.

Wobbrock [23] constructed a user defined gesture set, which reflected users' behaviour and was based upon the agreement of the participants involved in the study. The results suggested that the users didn't care about the number of fingers used in the gesture, preferred one hand over two, were strongly influenced by the desktop paradigm, but for some of the commands there was little agreement over what gesture would be appropriate.

A similar study was undertaken by Epps [8] who investigated user preferences for tabletop gestural interaction. They found that there was a high degree of consistency amongst participants for a small number of gestures and the most commonly used gesture was the index finger on the preferred hand, followed by spread hand and also a flat hand. An interesting observation was that the subjects raised their hands above the surface frequently when responding to tasks suggesting that the surface provides important feedback to the user, and acts as a convenient resting place for the hand.

Yuan et al [27] carried out a study with a group of users who had various disabilities that affected hand and finger movements and so they designed a set of command-like gestures to address this problem. Since many existing gestures for touchscreens rely upon full hand function, they may not be accessible to people with a physical disability. For instance, a person with contracted fingers, perhaps due to paralysis, may only be able to achieve a clenched hand and there may be limited movement of wrist. Thus, the possible contact shape of the hand on the surface will be very different from an able user. So, instead of using finger-based gestures, they used a clasped hand (a fist) and based gestural interaction on the trajectory and angle of the hand.

These studies suggest that the use of gestures may afford an alternative and more natural interaction method, since users can apply existing motor skills and interact directly with virtual objects, rather than having to develop the necessary skills to manipulate a pointing device. In addition, the ability to use both hands offers potential for a more efficient interaction method, and perhaps one that readily transfers existing manual skills. However, little work has been undertaken so far with respect to one and two-handed touchscreen interaction using gestural input for older users and perhaps those with age-related impairments and disabilities.

Bimanual Touchscreen Interaction

Gestural interaction using a multitouch screen offers potential for an improved user experience, and for two-handed interaction. But there is a need to study how people use their hands in computer interaction using gestures, and how tasks are divided and assigned to each hand. Although there has been extensive research in two-handed input [e.g. 5, 13] this has yet to be extended to multitouch interaction.

With multitouch gestural interaction commands may be easier to learn and remember if they are designed to reflect the manipulations of real world physical objects, since this is an existing skill that people already possess. Interacting with gestures can also be more

entertaining and may encourage people to play and explore an interface. In this sense, gestural interfaces should be made 'discoverable' so that people can find out for themselves how they work [18]. The iPhone [2] is a good example due to its simple and intuitive interface, with controls that are designed to help users understand how to operate them, without the need for a manual, and invite further exploration.

There are also many challenges that need to be addressed for older adult users, since with increasing age also comes many declines in physiological functions. The likelihood of developing a disability tends to increase with age, with many older people having at least one chronic disability such as arthritis, or a hearing or vision impairment [7]. Most touchscreens, and in particular virtual touchscreen keyboards, lack tactile response, so for users with visual impairments some other modality (such as sound) may need to be employed to provide adequate feedback in response to an action. The design of applications will need to be researched too, since existing interfaces operated through point and click often have screen objects which are too small or too close together to be operated easily using fingers, so are not well suited to gestural interaction.

Proposed Research

The aim of the research is to learn how older adults can make effective use of a multitouch touchscreen computer through two-handed gestural commands and perform an everyday computer task, such as sending an email. The same tasks will be undertaken by younger users and then the results will be compared. This is an emerging technology with only a handful of devices currently available, and a largely unexplored area for older computer users. The main objectives are the following:

1. To understand more about how older users can undertake computer-based tasks with a touchscreen using both hands.
2. To examine preferences for gestural interaction, and how gestures naturally map to tasks. This has already been partially explored by a few researchers, but not for older users, nor users with any (age-related) disabilities.
3. To study the difficulties encountered when using a multitouch touchscreen computer. For instance, the ability to form gestures may not be possible for adults with certain conditions such as Parkinson's disease or arthritis, and in this case it would be interesting to find out if alternative gestures could be employed for those gestures which are too difficult.
4. If particular gestures are not possible or not appropriate, then what are the characteristics of these gestures?
5. Which tasks are most suited to multitouch touchscreen interaction? For example, the direct manipulation of images when editing may be easier than using point and click with a traditional mouse. Conversely, selecting a single pixel when image editing may be simpler with a mouse.
6. To investigate novel techniques for gestural interaction when devising new applications specifically for multitouch touchscreen.
7. To evaluate possible performance gains, ease of use, learnability, and retention. . For instance, does direct interaction using a touchscreen actually promote learnability and retention?

The research will involve three linked phases starting with a paper and pencil exercise that will investigate and compare how older and younger users undertake a physical task. The first exercise consists of writing a simple letter, addressing it, enclosing a photograph and posting it. It is designed to find out more about how the hands are used in a simple everyday task, and how tasks are naturally assigned to each hand by the participant. The results of this will be used as the basis for the second study, which looks at a similar activity (apart from writing the letter), but displaying the objects as (static) images on a screen. Using a similar method as Wobbrock [23] participants will be provided with the effect of a gesture and asked to perform its cause. The outcome will be a set of gestures used in the performance of the actions.

Once some understanding of how users produce two-handed gestures in response to given stimuli has been gained, the results will inform the development of a multitouch email application. Rather than building a standard point and click interface, an application will be built that responds to gestural commands and the direct manipulation of screen objects.

The research questions include:

- What tasks would the users find most difficult to accomplish when using a real application and what tasks did not map to gestures easily or at all?
- Is the application easy to learn and remember?
- Are there gestures which the users could not carry out because of physical impairments? For instance, perhaps a user with arthritis could not manipulate an object because of the necessary gesture? What are the characteristics of the gesture that makes it difficult or impossible to use?

This research will provide a better understanding of how older adults use gestures to interact with a multitouch computing device, and provide some insights into the preferences of users, and limitations of two-handed touchscreen interaction due to physiological constraints. In addition, we will gain a better understanding of how gestural interaction differs between older and younger users.

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