CAR-TR-506
CS-TR-2487

June 1990

A new era for touchscreen applications: High precision, dragging icons, and refined feedback

Andrew Sears, Catherine Plaisant, Ben Shneiderman

Human-Computer Interaction Laboratory
Department of Computer Science
University of Maryland
College Park, MD 20742

(To appear in: *Advances in Human-Computer Interaction*, Vol. 3, R.Hartson, D. Hix, Ed.)

A new era for touchscreen applications: High precision, dragging icons, and refined feedback

Andrew Sears, Catherine Plaisant, Ben Shneiderman
Human-Computer Interaction Laboratory
Department of Computer Science
University of Maryland
College Park, Maryland

June 1990

(all the figures are at the end of the document)

1. Introduction

One goal of human-computer interaction research is to reduce the demands on users when using the computer. This can be done by reducing the perceptual and cognitive resources required to understand the interface or by reducing the motor effort to use the interface. The introduction of alternative input devices, such as the mouse and joystick, significantly improved some user interfaces. The touchscreen combines the advantages of these other devices with a very direct method of inputting information. Users simply point at the item or action of interest, and it is selected.

While many input devices allow interfaces to be customized, increased directness distinguishes touchscreens. Touchscreens are easy to learn to use, fast, and result in low error rates when interfaces are designed carefully. Many actions which are difficult with a mouse, joystick, or keyboard are simple when using a touchscreen. Making rapid selections at widely separated locations on the screen, signing your name, dragging the hands of a clock in a circular motion are all simple when using a touchscreen, but may be awkward using other devices. Even when a task can be accomplished with other input devices, users may have to clear their workspace for the mouse or press many keys to move the cursor.

Touchscreens have long been thought of as being simple to use. Unfortunately they have a reputation as being practical only for selecting large targets and as being error prone. Recent empirical research, as well as advances in touchscreen hardware, have dramatically improved the performance of touchscreens and the range of applications for which they can be advantageously used. Even with these advances, today most touchscreen applications emphasize the metaphor of 'buttons' being pressed on the screen. Tasks such as dragging an object on the screen, moving the marker on a slider, or free hand drawing are rarely attempted with touchscreens, but we believe that touchscreens can excel in such cases. This chapter presents recent empirical research which can provide a basis for theories of touchscreen usage. We believe recent improvements warrant increased use of touchscreens. Human factors specialists, psychologists, and computer scientists have a grand opportunity to influence further developments and refine theories in these new domains.

2. Advantages and perceived disadvantages of touchscreens

There are many advantages to touchscreens which have made them popular for public access situations.

2.1 Advantages

Directness:

One of the biggest benefits of a touchscreen is its directness. Unlike indirect devices such as a mouse, joystick, or keyboard, touchscreen users simply point at the desired object, and it is selected. There is no need to remember a complex syntax, search for the input device, remove visual focus from the objects of interest, or press multiple keys to move the cursor. More importantly, there is no need for users to map hand motions to cursor motions, as required by many other input devices. Sliding, dragging, and gestural input also benefit from the touchscreen directness.

Speed:

The touchscreen is the fastest selection device for many tasks. Users do not need to reach for the input device when it is time to make a selection as they often do with a mouse or lightpen. An additional advantage in many situations is the lack of a cursor when users are not touching the screen. Users simply touch the desired location rather than touching a cursor and dragging it to the desired location.

Ease of learning:

Touchscreens are easy to learn to use. Once users realize that they must simply touch the screen to interact with the computer, they quickly master simple actions such as touching buttons or dragging items across the screen. Unlike the mouse or tablet there is no need to learn and practice spatial reorientation and hand-eye coordination (Nielsen and Lyngbaek, 1990).

Flexibility:

Touchscreen interfaces offer flexibility not available with a keyboard. Each interface can be customized for each specific task performed. Users can choose which keyboard layout they prefer, QWERTY, Alphabetic, or Dvorak, since it is displayed on the screen.

No moving parts:

The lack of moving parts contributes to the durability of touchscreens that has made them popular for applications such as information kiosks at amusement parks, office buildings, or museums. Unlike a mouse or keyboard, only the touchscreen must be accessible to users, making loss or damage of hardware less likely. One system, an information kiosk developed for the Smithsonian, traveled to museums across the country for two years. These touchscreens were heavily used and never failed. However, the video monitors did ultimately fail from abuse during shipping.

No additional desk space:

Touchscreens free desk space for other uses. Many input devices, such as the keyboard and mouse, require desk space which may be very limited. A related benefit is that the touchscreen is in a fixed location. Unlike the mouse or lightpen there is no need to search for the device which may be hidden under papers. If the user is currently working with the computer, the screen must be accessible. This is particularly useful for applications requiring only occasional pointing.

2.2 Perceived disadvantages

There are also some problems that have been associated with touchscreens. Many of these problems have been overcome or reduced by improvements in touchscreen technology or design strategies that have been developed for touchscreen interfaces.

Low resolution:

This is one of the biggest misconceptions about touchscreens. Many people have reported on the low resolution of touchscreens. Some researchers have claimed that the resolution of a touchscreen is limited by the size of users' fingers, and others have claimed that selection of single characters would be slow if it was even possible. Recent research has shown that targets as small as 0.4x0.6mm could be selected with touchscreens (Sears & Shneiderman, 1990). The same research concluded that targets 1.7x2.2mm could be selected as fast with a touchscreen as they could with a mouse, with similar error rates.

Arm fatigue:

This could be one of the most significant problems with touchscreens. Using a touchscreen at the angle most monitors are currently mounted can lead to arm fatigue, making them difficult to use for extended periods of time. Renewed interested in reducing fatigue appears to have resulted in simple changes to the touchscreen position that will significantly reduce this problem (See Section 6 for more details).

Parallax:

When touchscreens were first introduced, the infrared technology was prevalent. Early infrared touchscreens had the touch sensing devices mounted above the surface of the monitor. When users' fingers were close enough to the screen, the infrared beams would be broken, resulting in a touch. This could occur long before the user meant to touch the screen. Newer infrared touchscreens, and all other technologies, sense touches much closer to the monitor surface, if not directly on the surface, reducing the problem with parallax. Software strategies have also been explored that reduce problems created by residual parallax by correcting for offsets created by the parallax and providing feedback to users about their exact position.

Glare and smudges:

Glare and smudges on the monitor are of concern to many designers. Mounting the monitor at a better angle, using lightly ground glass surfaces, and paying careful attention to the lighting near the workstation can significantly reduce the glare problem. Smudges are unattractive and can obscure the display. Reducing smudges simply requires users to clean the monitor occasionally. On the other hand we find that some touchscreens have less problems with accumulating dust than standard monitors. In our laboratory environment, we find ourselves cleaning the mouse pad and mechanical parts more often than we clean the touchscreens.

Obscuring of the screen:

The fact that users use their fingers to make a selection by touching the screen implies that the users' hand will obscure a part of the screen. Careful design of the interface, placing selectable items in locations that will keep the user's hand from obscuring the screen, can significantly reduce this problem. When possible, the handedness of users should be considered when designing interfaces, or users could be allowed to customize the software for the left or right hand.

Limited tactile feedback:

Visual and audible feedback should be used to compensate for limited tactile feedback in button applications. Tactile feedback is particularly important when performing rapid button presses without watching the screen. An example is typing on a touchscreen. When users type on a traditional keyboard, the edges of the keys help orient their hands and the motion of the keys indicates when they are pressed. These cues are not available with touchscreen keyboards. Visual and audible feedback can supplement the physical contact with the screen to help compensate for the absence of key motion, but identifying when the edge of the touchscreen key is touched is more

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.

WHAT WILL YOU BUILD? | sales@docketalarm.com | 1-866-77-FASTCASE