



Multi-Touch Overview

Introduction

The recent launch of touch-enabled products such as the Apple iPhone has generated much media attention and has highlighted the touch screen as the up-and-coming human interface for both computers and phones. Many example applications have been demonstrated, aiming at the entertainment, gaming, hospitality, retail and service industries.

Multi-touch is being heralded as a new innovation, whereas in fact, it is an integral part of U-Touch's existing, commercially available optical touch technology, and has been the subject of many research projects for over 20 years.

This document introduces multi-touch in general, discusses U-Touch's multi-touch capability, and outlines U-Touch's plans for future development of their unique technology.

What is Multi-Touch?

Multi-touch simply refers to a touch-sensitive device that can independently detect and optionally resolve the position of two or more touches on screen at the same time. In contrast, a traditional touch screen senses the position of a single touch and hence is not a multi-touch device.

- A single-touch touchscreen allows users to interact with software by touching the screen instead of using a mouse, for example. It provides an intuitive interface—the pointing device (your finger or a stylus) operates on the same surface as the object you want to manipulate. Single touch allows you to do many operations—clicking, dragging and painting—in an intuitive way.
- A multi-touch touchscreen, not only provides the intuitive human-computer interface as above, but also surpasses the capability of traditional pointing devices. Multi-touch provides a much richer set of gestures. For example, you can use your finger and thumb in a stretching, squeezing or rotating action to manipulate an object on screen.
- Furthermore, multi-touch allows you to perform more than one action at the same time. Several video clips (including ones featuring U-Touch) demonstrating the potential of multi-touch have recently appeared on YouTube™.

The advantages of multi-touch can be likened to playing a piano with all your fingers and being able to play chords, as opposed to playing it with one finger.

Touch Terminology

“Detect” refers to the ability to sense that a touch has occurred somewhere on screen.

“Resolve” refers to the ability to report the coordinates of the touch position.

“Multi-user” refers to the ability for two or more users to interact with one or more applications at the same time via the touch interface.

History

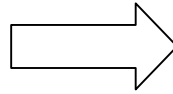
For an overview of the development of multi-touch over the past 20 years, see the following web page by Bill Buxton of Microsoft Research: <http://www.billbuxton.com/multitouchOverview.html>

U-Touch's Current Touch Capability

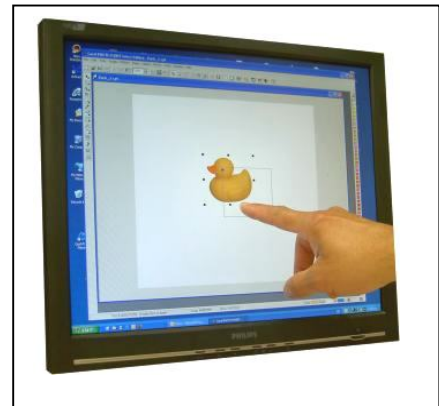
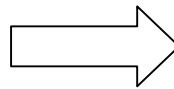
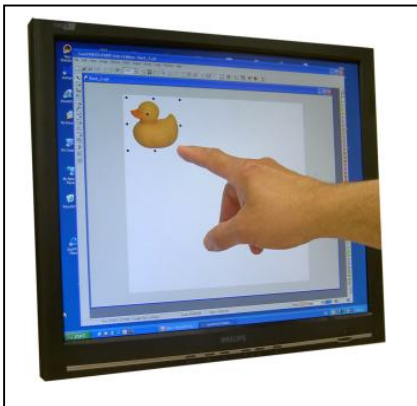
U-Touch's standard optical touch hardware can detect two touches on screen. The firmware can resolve the position of two simultaneous touches (with some limitations, described later), the size of each touch area and the usual mouse functions of click, drag, double-click and right-click. These functions are illustrated below.

Standard Point and Click Operations

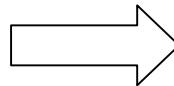
- Touch the screen for click
- Touch and move for drag
- Double touch within a configurable time for double-click
- Touch and hold for a configurable time for right-click



Single Touch Example—drag

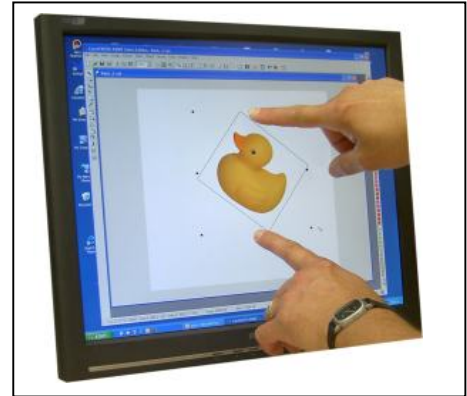
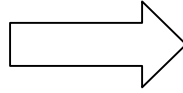


Two Touch Example—resize and move simultaneously



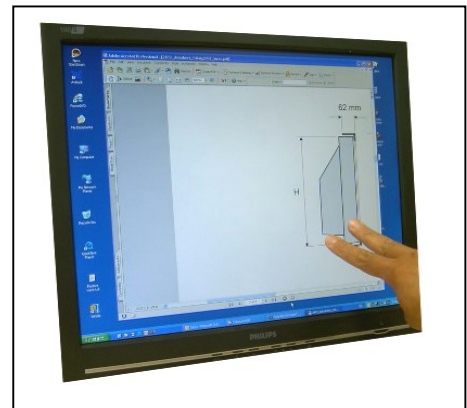
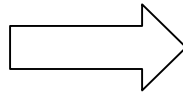
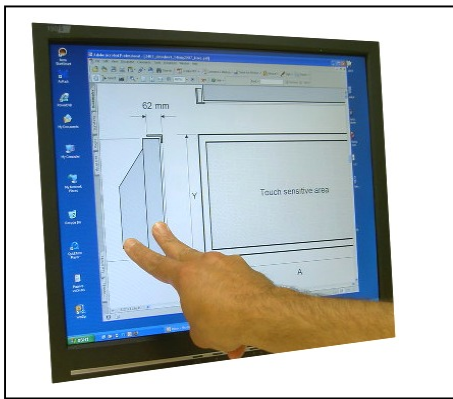
Two Touch Example—rotate

Using two hands or two fingers on one hand, you can hold one steady and move the other around it to rotate the object.



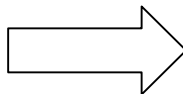
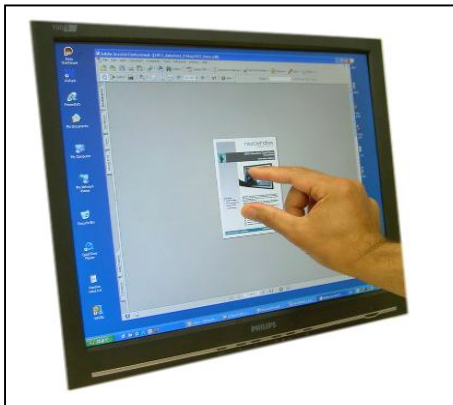
Two Touch Example—application window pan

Two-finger move can be used to pan left/right and up/down within an application window.



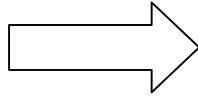
Two Touch Example—application zoom

Two finger pinch can be used to zoom applications like Adobe Acrobat, Internet Explorer, or graphics programs.



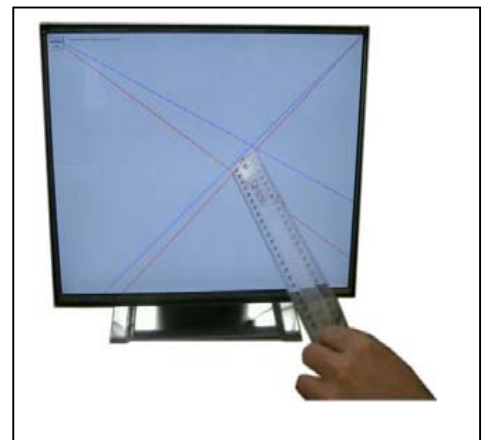
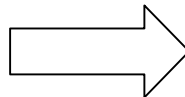
Two Touch Example—toggle applications

Two-finger touch can be used to toggle applications in Microsoft Vista



Size Recognition

- This picture illustrates how U-Touch's optical touch recognises and reports the size of an object.
- Touch size recognition can be used for many innovative applications.



Applications

U-Touch provides versatile optical touch-screen technology that is scaleable from small format 12" LCD touch monitors to very large format plasma and LCD displays. U-Touch's partners are developing and rolling out exciting and innovative applications of the technology in many fields.

Multi-touch and multi-user technology has huge potential in areas such as:

- Interactive whiteboards
- Medical systems
- Gaming interfaces
- Manipulation and organisation of files including photos, videos and other media.

Applications of U-Touch's technology include vertical, horizontal and touch surfaces at any angle.

U-Touch is developing a demonstration multi-touch application to show the potential of moving, resizing and rotating shapes on screen.



Gestures

Gestures allow you to instruct an application to do something depending on how you move your finger across the screen.

Some examples are:

- Causing a window to scroll using a horizontal or vertical gesture anywhere within the window, rather than having to locate and use the scroll bars.
- Gesturing left or right in a presentation or browser to go forward or back a page as required.
- Dismissing a program with a gesture.
- With two touches, you can gesture with both hands at the same time. For example you can simulate an expanding action by moving both hands rapidly apart.

Microsoft Vista

U-Touch's touch screens support the "Flick" functionality available in digitiser mode of Microsoft's Vista operating system. The system can be configured to interpret flick gestures at different angles as different commands. This requires only single-touch functionality.

Ongoing Development

U-Touch is currently researching ways to develop its technology in order to enhance multi-touch capability. Areas of research include increasing the number of optical sensors (to better resolve multiple touch points) and increasing processing power.

Currently, U-Touch's standard products have two optical sensors. U-Touch is evaluating the use of four optical sensors. Although more costly in production, four sensors will enable full, accurate, three-touch coverage over the whole screen.

In order to better handle the processing of multiple touches, U-Touch is researching the suitability of an ARM micro controller to replace the current processor.

U-Touch's ongoing miniaturisation of optical sensors and other components will continue to ensure that the technology can be integrated into smaller display bezels.

Technical Details

Multi-Touch Data

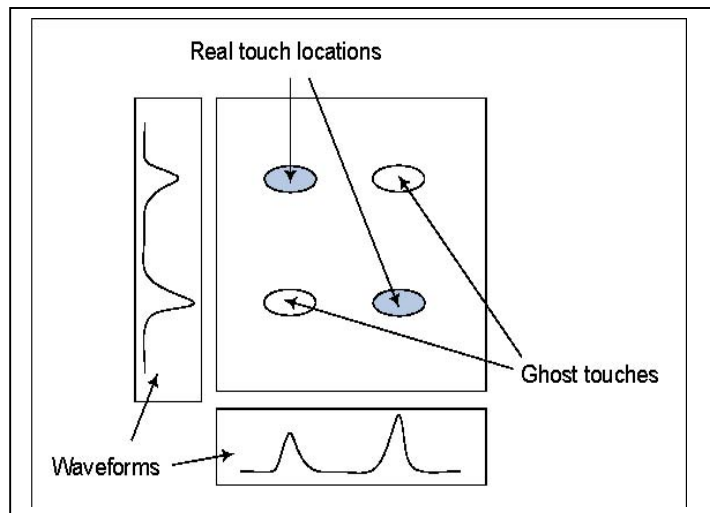
The optical sensors detect the position of the finger (or stylus) as it touches the screen.

The firmware reports the following data for each of the two touch positions:

- Touch event and type (touch down, touching, or lift off).
- Continuously updated X and Y coordinates during touch.
- Width of touch as seen by the sensors.

Limitations

- Touches should touch down 20 ms or more apart for maximum two-touch resolvability
- In most multi-touch systems, when more than one touch is present, there are two possible positions for each touch. This is illustrated below for a rectangular coordinate system.



The real touch locations can be resolved in software. The other two possibilities are called “ghost touches.”

In many operations (such as rotating and stretching a shape), ghost touches are just as useful as regular touches in the computation.

- When moving touch points leave an occluded state (two touches in line with one of the optical sensors), there can be further ambiguity between the real and the ghost touches. This can be resolved in software to a reasonable degree of certainty.

U-Touch’s ongoing research and development as described earlier is constantly improving performance in all of the above areas.

Derived Information

In addition to gathering raw data, in mouse mode (see below), the software calculates and provides the following for each of the two touch positions:

- Duration of touch.
- Time between two touches.
- Size of touch area.
- Direction of travel (if finger moving across the surface).
- Velocity of travel.
- Acceleration of travel.

U-Touch’s firmware can be set to operate in three different modes: mouse mode (the default), multi-touch mode and digitiser mode.



Mouse Mode

In mouse mode, the firmware converts touch events to regular mouse operations, including left click, drag, right click and double click.

Multi-Touch Mode

In multi-touch mode, touches are sent through the USB HID communications channel as raw data (touch event, XY coordinates and touch width).

Digitiser Mode

In digitiser mode, touch events are passed directly through the touch screen's HID digitizer endpoint. Processing is done by the application or digitiser driver.

U-Touch's Touch API

The touch events, data and derived information can be used in any way an application wants. U-Touch is developing an Application Program Interface (API) that will allow programmers to easily access the information. Communications will be via HID-compliant USB.

The touch API will take the form of a DLL that provides useful functions for application developers.

For example, the DLL will be able to report what type of touch movement is happening—a straight line or a rotational drag.

Conclusion

U-Touch's optical touch technology supports single-touch functionality over the full range of touch screen sizes from 12" to 120". In addition, it supports detection of a second touch, and resolution of the second touch with limitations that can be mitigated in software. U-Touch's ongoing miniaturisation of components coupled with increased number of sensors and increased processing power will allow more and more sophisticated multi-touch applications to be supported in the near future.

U-Touch is also developing a multi-touch demonstration application and an API for programmers that will enable them to produce ground-breaking and imaginative applications that will fully exploit the exciting potential of multi-touch.