

Design Course

Touch Screen Gestures

Touch Screen Technologies

by

Prof. Keyur Sorathia

DoD, IIT Guwahati

Source:

<https://www.dsource.in/course/touch-screen-gestures>



1. Introduction
2. Types of Touch Screen
3. Finger and Touch Targets
4. Touch Targets
5. Gestures of Touch Screen
6. Touch Feedback
7. Design Consideration
8. Contact Details

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<https://www.dsource.in/course/touch-screen-gestures/introduction>

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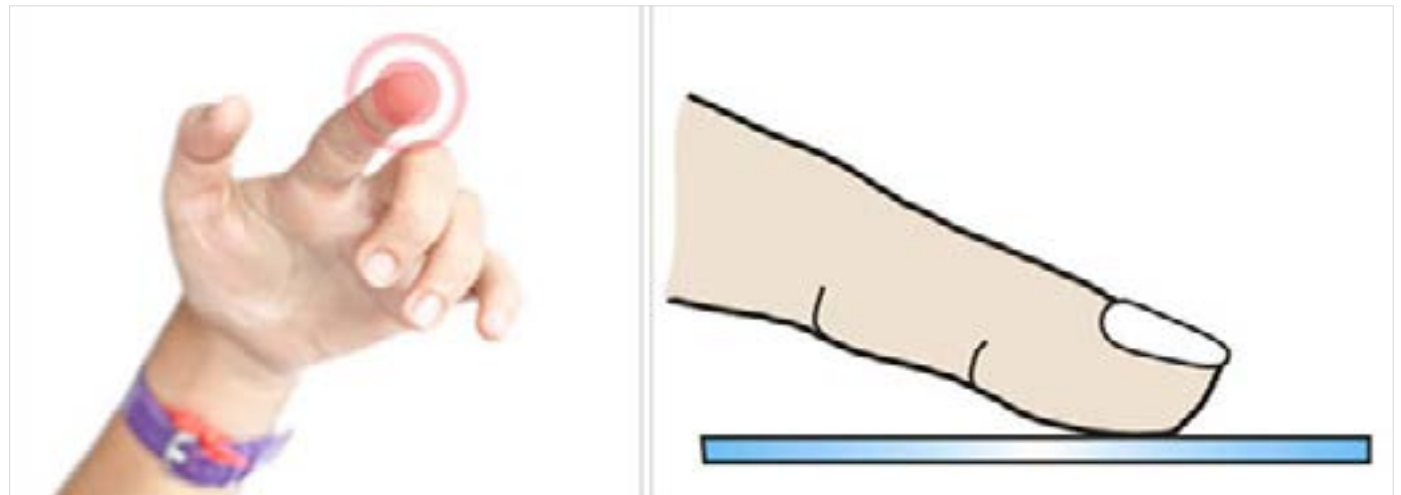
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Introduction

Touch screen is a screen display that responds and is sensitive to the touch of a finger or stylus and provides direct interaction with information. It is most widely used in automatic teller machines (ATM), interactive displays in retail environments, GPS systems, computers, and recently in mobile phones. Penetration of touch screen mobile phones has made a significant jump, especially after the introduction of Apple's iPhone. Touch screens can be easy to use with almost no training or less training if an application is designed appropriately.

There has been development of touch screen in almost all possible areas of mobile application, health care, railway and bus route information application, museum, touch screen devices such as city guides, office environments, educational applications, industrial control panels, entertainment sector, gaming, computers and laptops, household appliances and many more.

In the current scenario, due to technological advancement and ease of use, a wide variety of touch screen devices are available such as mobile touch devices, tablets, interactive kiosks, and large wall-mounted, free-standing and encased touch screen devices. Here, we introduce you to touch screen technologies, finger and touch target consideration, patterns and gestures used to make touch screen interfaces and design considerations of designing touch screen interfaces.



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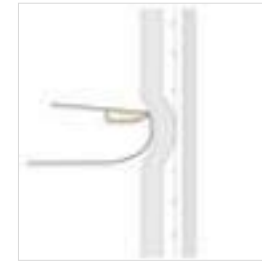
<https://www.dsource.in/course/touch-screen-gestures/types-touch-screen>

Types of Touch Screen

Here, we describe few touch screen technologies and their usage that are widely used. Touch screen technologies are not limited to technologies mentioned below, several other touch screen technologies can be found for specific purposes. Few types are mentioned below:



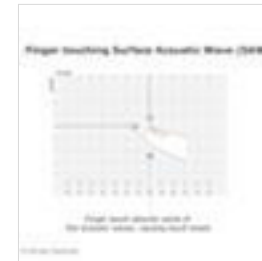
Infrared Touch Screen



Resistive Touch Screen



Capacitive Touch Screen



Surface Acoustic Wave



Wii Based Touch Screen

Infrared touch screen	Resistive touch screen
LED beams	Resistive
No	Periodic calibration

Comparison of all Touch Screens

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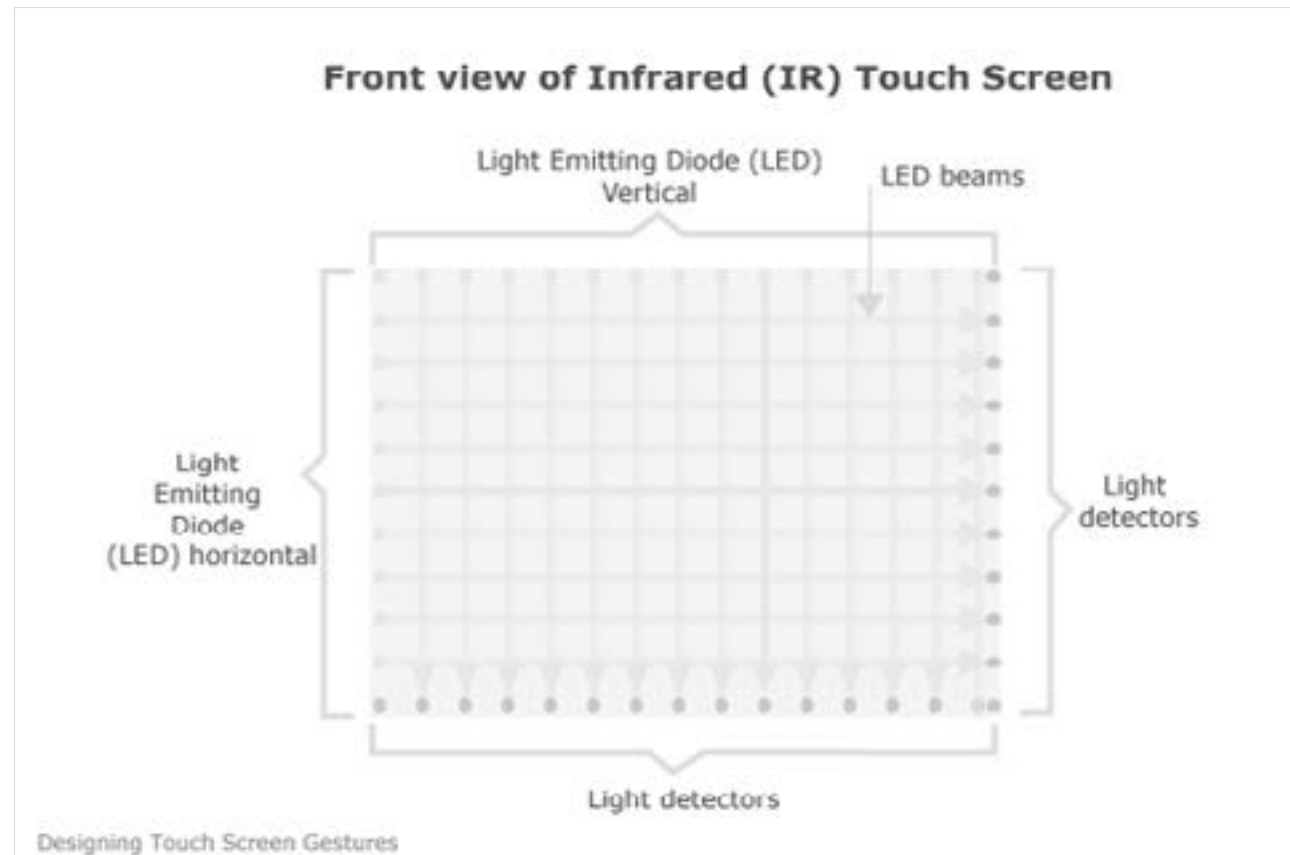
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Infrared Touch Screen

An array of infrared Light Emitting Diodes (LEDs) and photo detector pairs are placed around the edges of the panel. The LEDs are placed both horizontally and vertically creating a grid of infrared light beams. When a finger or any object touches the screen, the grids of LED beams are obstructed, helping to find out the X and Y positioning of the object approaching the touch screen.

Infrared touch screen can detect any object (e.g. finger, stylus, glove etc.) approaching the touch screen, which makes it a desirable technology to use. Additionally, it can be scaled to any size without losing the resolution. Light transmission is also considered better than resistive touch screens.



The figure above showcases the front view of infrared touch screen.

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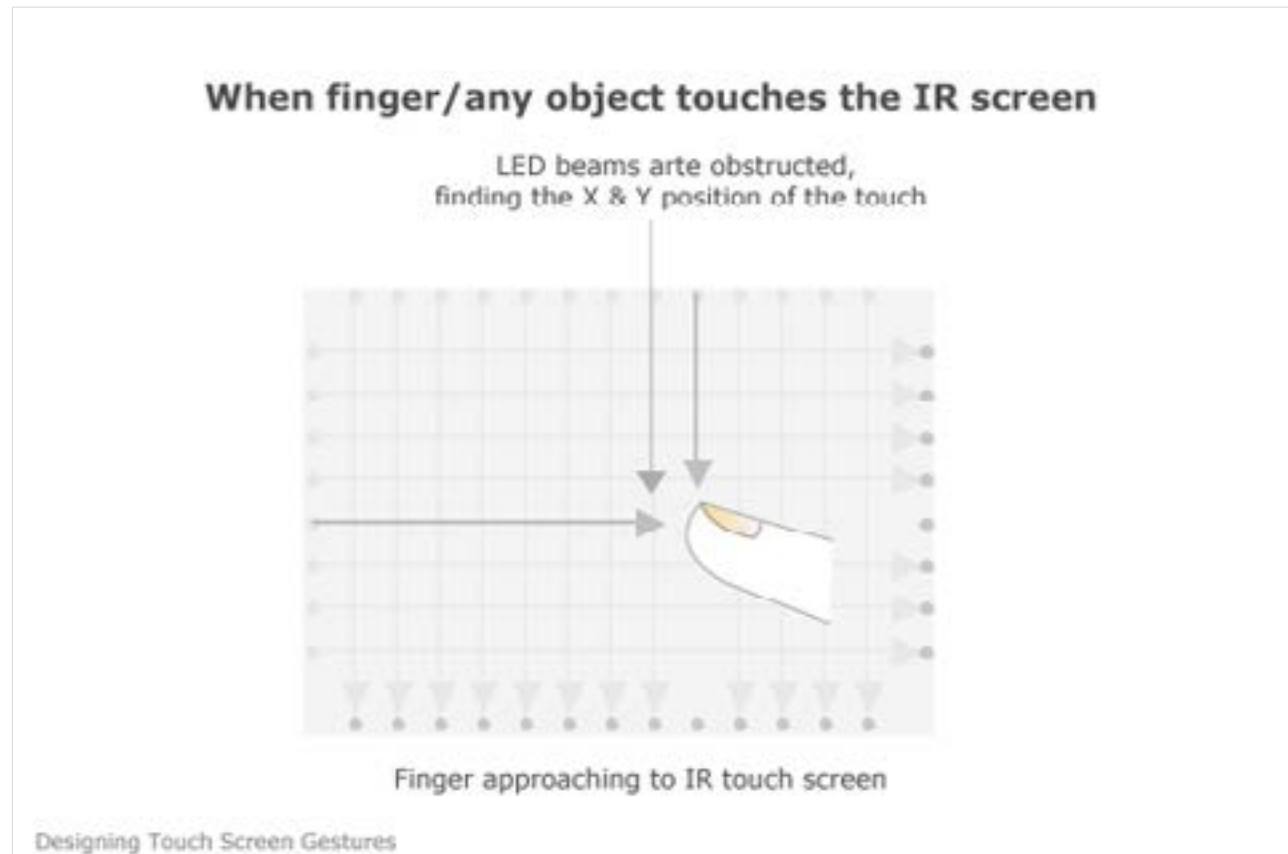


Figure above showcases the touch event caused in infrared touch screen.

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Resistive Touch Screen

Resistive touch screen is made of two most important conductive layers. These layers are electrically conductive and separated from air gaps or microdots. When a finger or any other object (e.g. stylus) touches the outer layer of touch screen, the connecting points of two layers act as a voltage divider. In simpler language, when a finger or any other object (e.g. stylus etc.) touches the outer layer of the touch screen, there is a notified change in electric current at the connecting point of two conductive layers, which eventually is registered as a touch point.

The two conductive sheets have horizontal and vertical lines. When finger or any other object touches the outer layer of the touch screen, the lines help detect the x and y position, eventually helping register the precise location of touch.

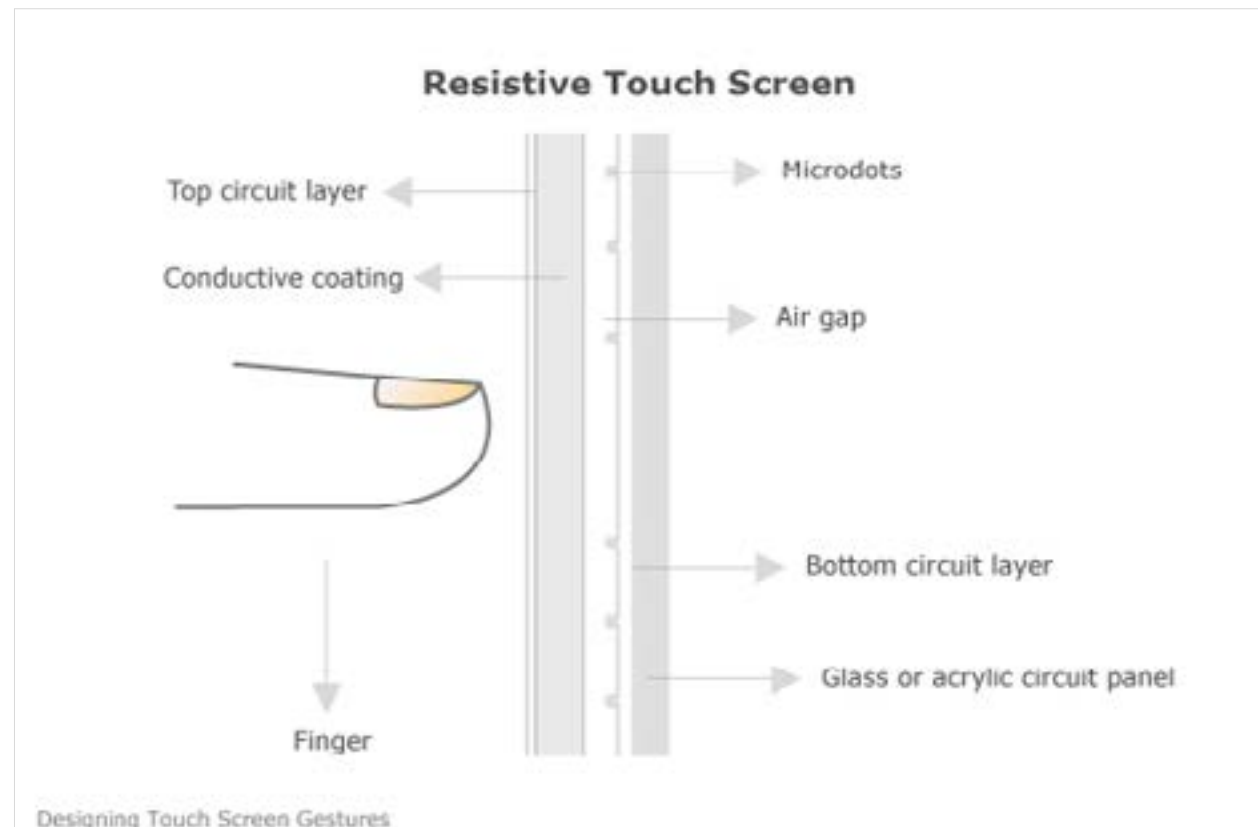


Figure showcasing the internal structure of resistive touch screen.

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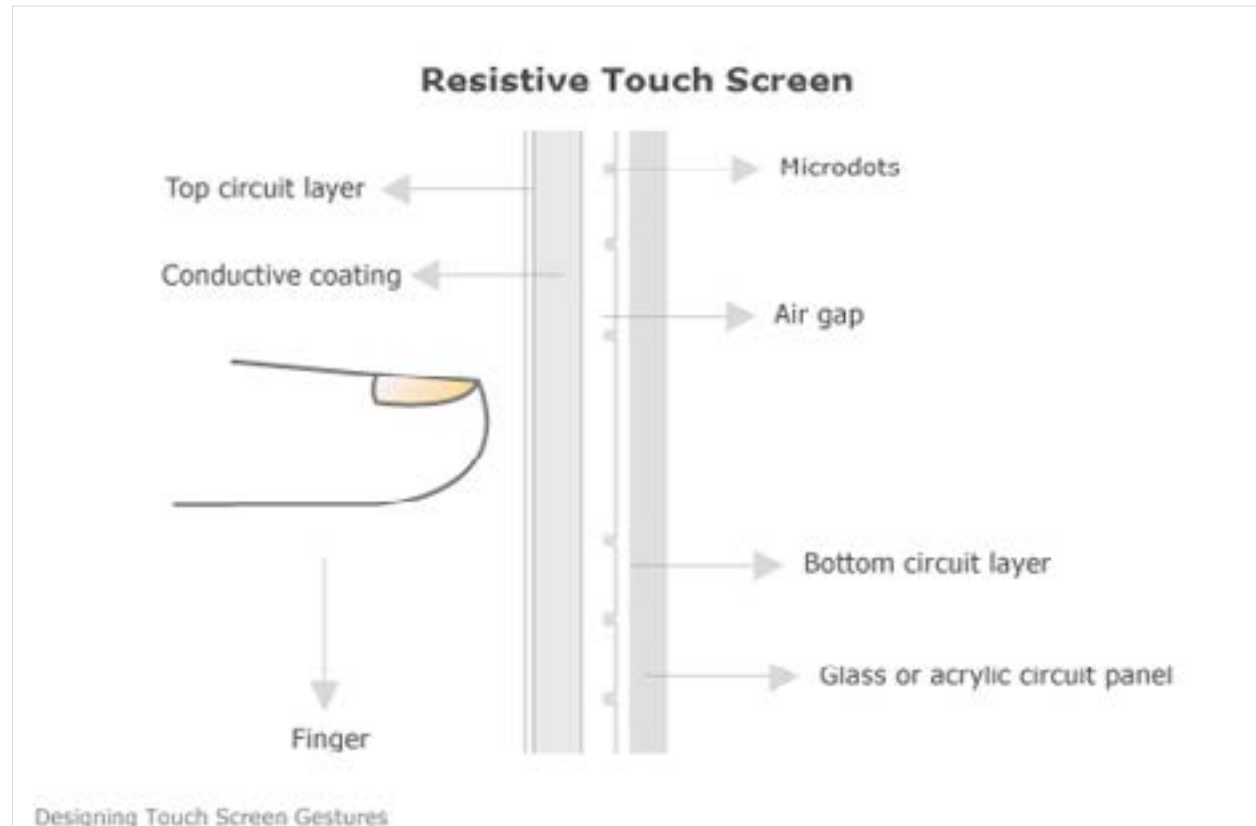


Figure showcasing the internal structure of resistive touch screen after the finger pressed.

Resistive touch screen can be used with finger or stylus. It is not limited to a human finger touch. It is beneficial to use in cold environments where people wear gloves to interact with monitor. Resistive touch screens are sufficiently accurate for usage in shopping malls, ATMs; touch screen kiosks etc., though the endurance (number of touches) is relatively less.

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Capacitive Touch Screen

In a capacitive touch screen panel, a conductive layer is placed on the top of glass layer of the monitor. The conductive layer is made up of transparent capacitive material (e.g. indium tin oxide-ITO). A small voltage is applied to the conductive layer that resulting in a uniform electrostatic field. In a simpler language, an electric charge is stored on the conductive layer. When a human finger touches the touch screen, some of the electric charges are transferred to the user, which decreases the charge on the conductive layer. The decrease in the charge is measured by circuits located at each corner of the touch screen panel. A relative difference in electric charge is calculated, showcasing where the touch event took place. This information is passed on to the computer software and appropriate action is taken to accomplish the task of the user.

Capacitive touch screens are dependent upon conductive properties of an object; so human finger is easily detected. Normal gloves and stylus does not work with capacitive touch screen due to their non-conductive properties. Capacitive touch screen does not rely on the pressure given to the surface, which makes it more responsive to relatively complex gestures such as pinch & shrink to zoom out, pinch & spread to zoom in, slide, swipe etc.

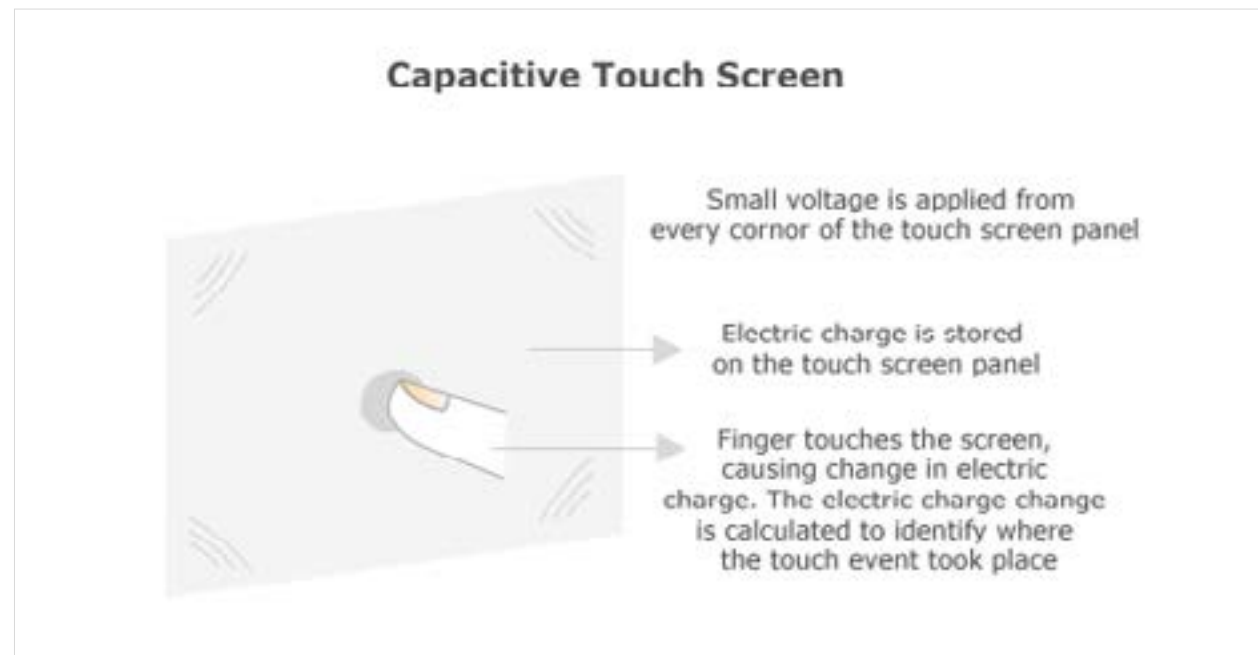


Figure showcasing the working of capacitive touch screen.

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Surface Acoustic Wave

Ultrasonic waves are sent across the glass panel with the help of transducer and reflector in Surface Acoustic Wave technology. Transducer and Reflector are important elements in SAW. Receiving and transmitting transducers are placed across X and Y-axis of the touch panel. The system controller sends electrical signals to transmitting transducer that converts them into ultrasonic waves. Transmitting transducer emits ultrasonic waves to the edge of the touch screen panel where reflectors are placed. The reflectors convert the ultrasonic waves into electrical signals and send them to system controller.

When a user touches the panel, the ultrasonic waves are absorbed and touch event is detected at that point. This information is sent to the system controller and appropriate action is taken further. Like infrared touch screens, Surface Acoustic Wave technology does not have a number of layers. Surface Acoustic Wave has higher image clarity and light transmission. A finger, glove or stylus can be used to detect the touch event.

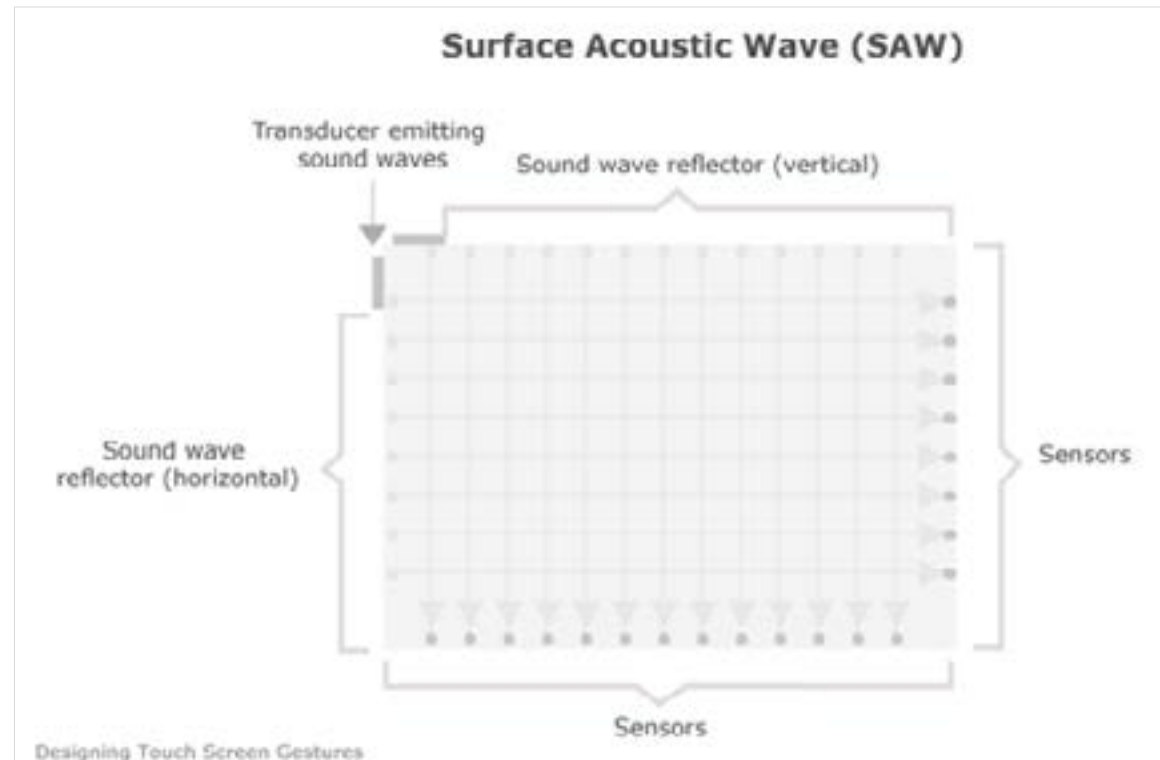


Figure showcasing the internal structure surface acoustic wave based touch screen.

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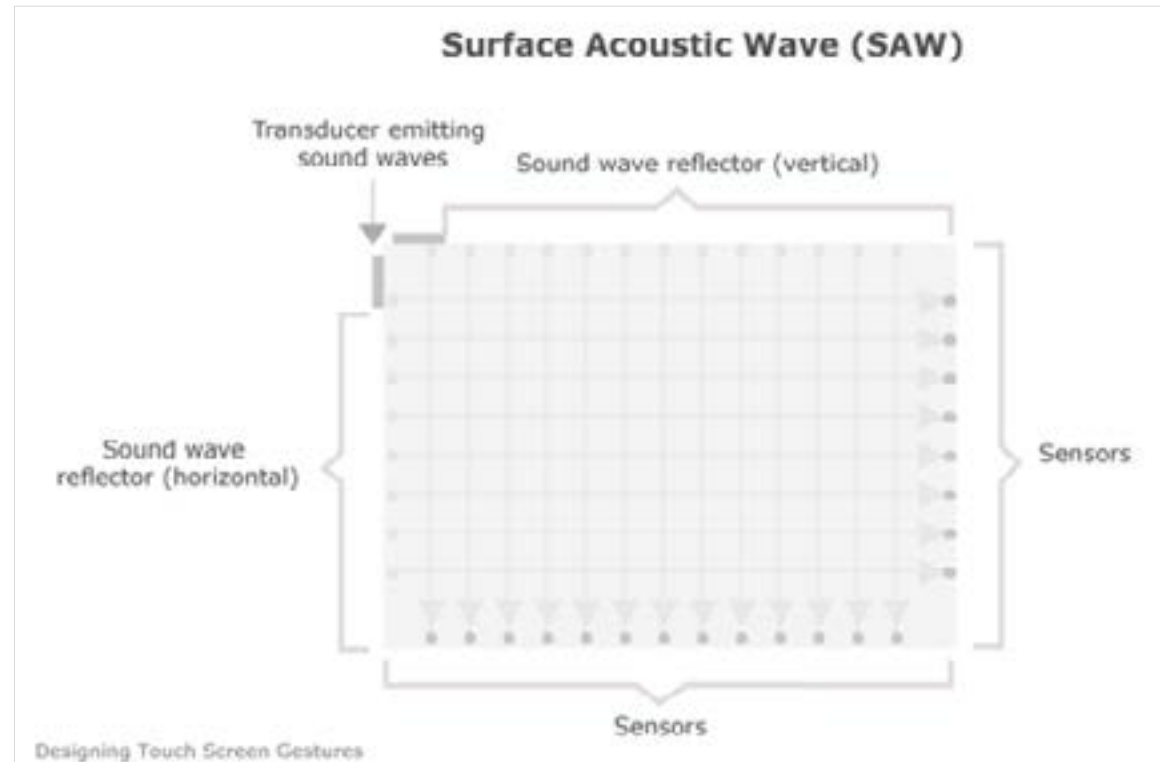


Figure showcasing the operation when a finger approaches SAW based touch screen.

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Wii Based Touch Screen

Wii remote console based touch screen was developed by Johnny Lee. Wiimote is a bluetooth enabled gesture based remote control that is made available with Nintendo Wii gaming console. To make a touch screen, Wii remote console is sufficient instead of a complete gaming console.

To make a Wiimote based touch screen:

- A button enabled infrared (IR) light pen,
- A Wii remote console and
- A software (developed by Johnny Lee) is required.

Wiimote detects the infrared light attached to pen. When the button of the pen is pressed, software detects the positioning of the pen on the screen and sends a signal to the software; causing it a touch event. The detection can also be done by keeping the pen away from the screen. It does not require touching the IR light pen on the screen. The touch screen size can be scaled from a normal laptop screen to a large projected screen.

Wii based touch screen is relatively cheaper than other touch screens, though it requires a small set up to be made to make Wii based touch screen. Wii based touch screen works well with rear projection.

More details can be found at Johnny Lee's website: <http://johnnylee.net/projects/wii/>
Wii remote console can be bought in India in the range of INR 1600-2000.

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Comparison of all Touch Screens

	Infrared touch screen	Resistive touch screen	Capacitive touch screen	Surface Acoustic Wave touch screen	Wii remote based touch screen
Technology used	LED beams	Resistive	Electric charge/electrostatic field	Sound waves	Infrared light detection through Wii console
Calibration	No	Periodic calibration	Periodic calibration	Periodic calibration	Every time calibration required
Multi touch possibility	Can go up-to two touch event detection	No	No	No	Can go up-to 4 pen/touch detection
Input method	Any pointing device	Any pointing device	Human body part/conductive object	Any pointing device	Specialized pen/specialized glove
Image clarity and transmission	High	Low compare to other technologies	High	High	Is independent of technology
Pressure required to activate	Very low	Low	Very low	Very low	No
Touch accuracy	Depends upon the spacing between IR beams	Constant pressure required for high accuracy	High when touched with finger	High	Depends upon the setup created and IR light visibility to Wii console
Applications	Can be used in point of sale system, advertisement at kiosk, information kiosk etc.	Durable and can be used in variety of environment. Point of sale system, restaurant, industrial control system	Good for human finger touch. Highly used in touch screen mobile phones, information kiosks, ATMs etc.	Comparatively expensive, highest clarity, can be used for public information kiosk, computer-based training etc.	Can be used for research purpose to build low cost touch screen, touch screen white board in school and education environment

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Finger and Touch Targets

Selecting Finger Size:

Diameter of an adult finger is typically of 16mm to 20mm. Generally, for pushing buttons and using touch screen, finger pad is used. They are narrower than full finger but wider than the fingertip. The size of the finger pad is 10-14mm.

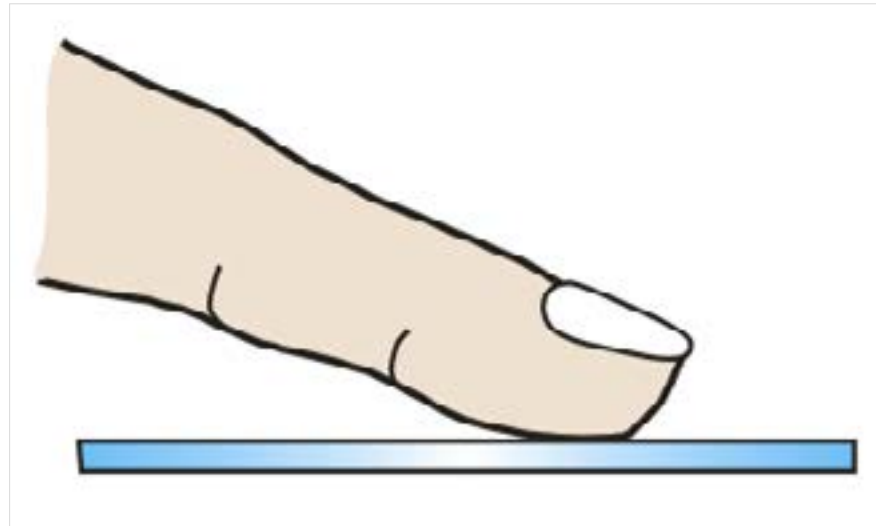


Image of a finger pad.

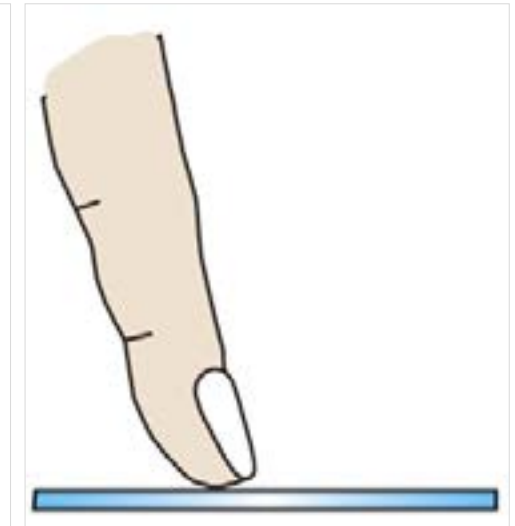


Image of a fingertip.

Fingertip is narrower than finger pad and full finger. The size of the fingertip is 8-10mm.

Calculating Target Size:

The interface element where user is asked to touch to select, should not be smaller than 1cm diameter or 1cm*1cm

- “Size of the target element = Target size in inches (0.4 inch) * Pixel per inch”
- “Pixel per inch (PPI) = Screen width in pixel/screen width in inch”

The higher the PPI, the larger your interface elements will have to be to create suitable touch targets.

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Touch Targets

Generally, the target size of the control is the same as the visible control.

E.g. If the button size is 100 (width) X 40 (height) (pixel), the target size of the button is kept same as 100 (width) X 40 (height) (pixel).

Though in some cases, there are possible variations based on the screen size, application content and context of use. There are majorly two ways around the size limitations of touch targets.

Iceberg Tips:

Iceberg tips are the controls that have larger targets than visible ones. The touch target size can be increased without increasing the size of the element itself. Sometimes as designer, you may not want to element size to increase from a specific size, and then iceberg tips can be helpful. There has to be enough space between elements to create this effect.



Iceberg Tips.

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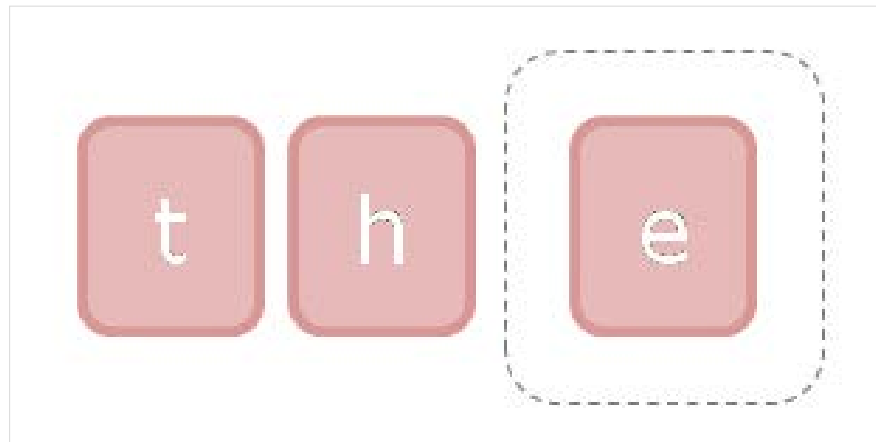
Adaptive Targets:

Adaptive targets can be called an extension of iceberg tips. They are created algorithmically by guessing the next item the user will touch and then increasing the touch target appropriately.

This trick is generally used in touch screen keyboards, such as i-phone.

For Example:

On a touch screen based keyboard, if user types “t”, or “h”, the system predicts the next alphabet to be typed and increases the target size of “e”, completing to “the”. Though designers and developers need to be careful not to over predict user's intentions.



Adaptive Targets.

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Gestures of Touch Screen

Patterns for touch screens described here, in some cases can also be used for free form interactive gestures.

These examples showcase a set of touch gestures, though these are not meant to be the only set of touch gestures. The touch gesture may vary and heavily dependent upon context of use, type of application, touch screen technology etc.

Tap to open/activate/select:

Tapping on a specific area or specific interface objects will open or activate the element. Whenever there is a need for a target object to be activated or a button to be pushed to active, tap to open/activate can be used.

In addition to open/activate, tap can be used to select as well. Here, one tap selects an element and another tap opens/activates. Tap to select is used where user taps on a target object to select for manipulation. Also, when user needs to select multiple options from list of choices, tap to select can be used.

Tap is a simplest touch gesture and is a better replacement for left mouse click. As mouse over event occurs in pointer based interactions, there is less possibility to trigger the same event in touch based interactions.

There are two types of taps to open/activate:

- Open/ Activate/ Select on press
- Open/ Activate/ Select on release

Most of the mechanical buttons use activate on press method, though in case of touch screens, it is better to use open/activate/select on release method as it gives user time to move off the button if he changes his mind, especially if tapping performed to an action that cannot be undone.

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Tap to Select on Press.



Tap to Select on Release.

Tap to Stop:

When an action takes longer time to perform or user wants to interrupt during ongoing performance, especially if the ongoing action is displaying a set of screens or contents that user may want to act on it, tap to stop can be used. When a particular action is performed, tapping can be used to stop the performance of the action. e.g. tapping on the screen to stop the scroll.

Tap to stop can cancel/stop the action, or pause the action depending upon the need.



Tap to Stop.

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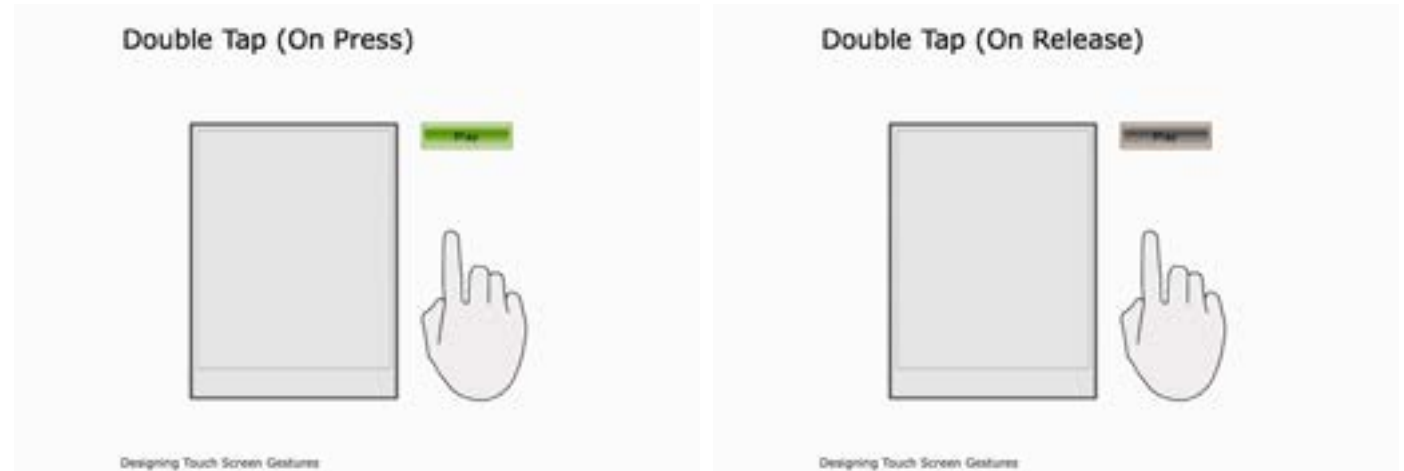
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Double Tap:

In few handheld devices, double tap is used to select an object and perform action associated with that object. When user needs to choose from multiple options associated with the selected object, double tap used.

First tap on the screen selects the object, second tap can be either choosing from multiple options or viewing the details of selected object.



Double Tap On Press.

Double Tap On Release.

Drag and Drop:

Drag and drop is basically placing a finger on the top of an object and moving it along towards a new location, with the help of a finger. Users need a gesture to move objects from one place to another, so pushing and pulling an object to different place is a natural gesture to move them.

It can be used when object needs to be placed at different locations by user, for scrolling purposes, sliders etc.

In drag and drop, object needs to be tapped and then pushed or pulled to another location. Drag and drop can also be combined with tap to select, where object is selected first and then moved it across the screen. Drag and drop can also be constrained to be moved in a particular direction. E.g. moving an element just on left side or right side. Similar way elements can be dragged only horizontally, not vertically. Use shorter drags, users may not be able to understand longer drags and may cause accidental drops.

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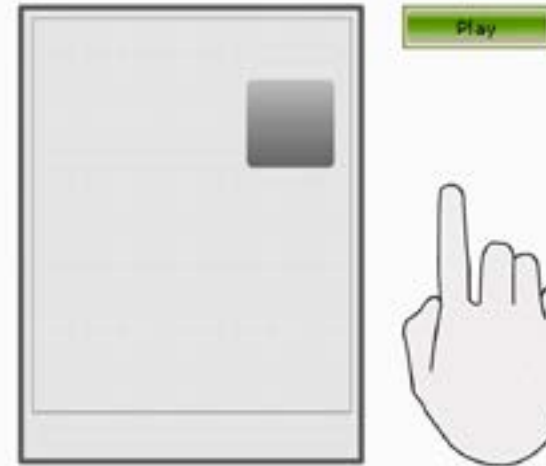
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Drag and Drop



Drag And Drop.

Flick:

If a set of contents, a screen needs to move away, flick gesture can be used. A slight flick by index finger in any direction can be used to flip through screens, move away contents and help quickly flip through contents. Here, the index finger slightly touches the screen and moves in a straight line in one direction. If a tip of a finger is used, it can be considered as a flick and if the finger pad is used, which relatively takes more time on screen, can be considered as push or pull. Based on the speed of the flick, the movement of the object will continue after the gesture is complete, slowing to a gentle stop.

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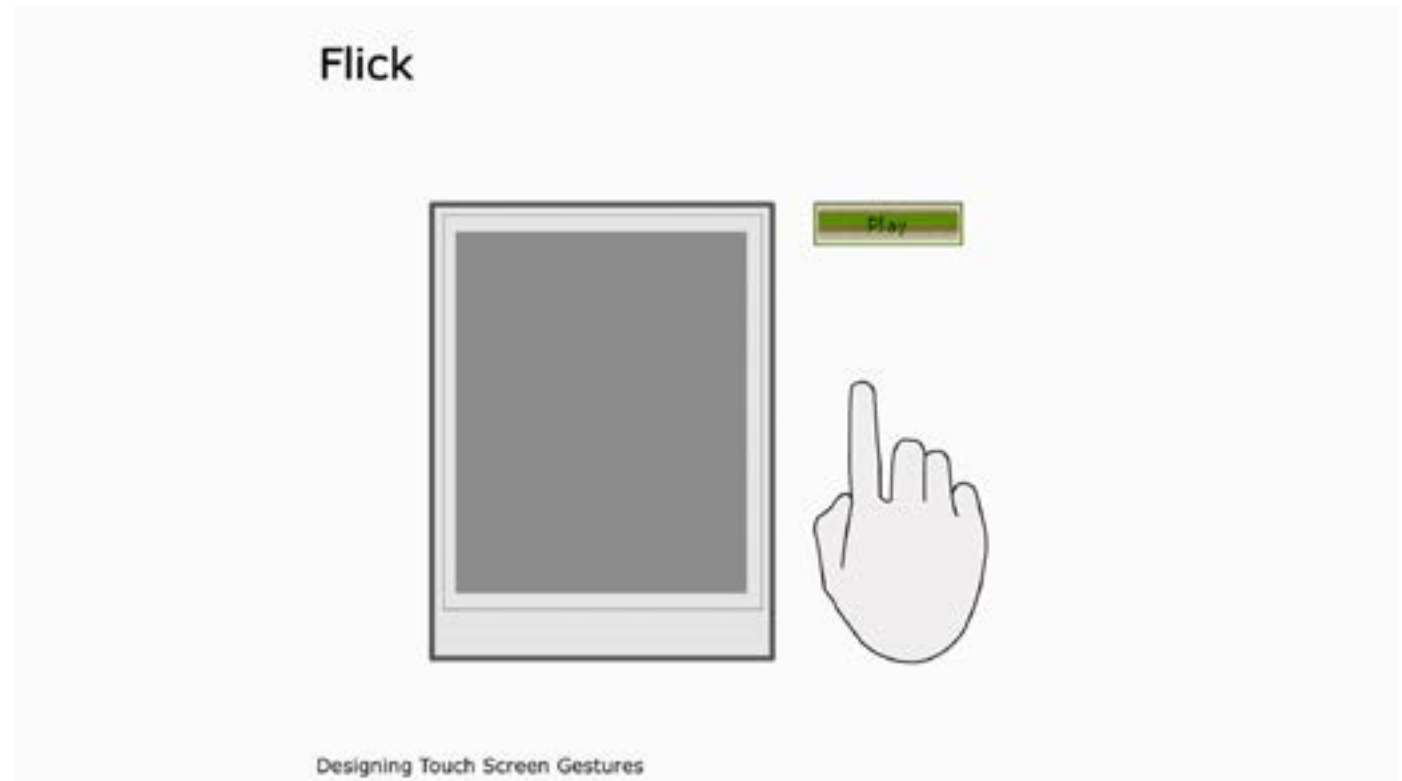
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Flick.

Touchdown and Drag:

When contents such as a number of files, folders, text etc. needs to be selected together on a screen, needs to place at different location or perform any action, *touchdown and drag* is used. It is similar to dragging a mouse around the computer desktop to select target objects.

Index finger is used to touch the screen (where object is not present), slides the finger around the selected area of the screen. A visual feedback is essential to display the selected area on the screen and the selected objects. Further, necessary actions can be performed on the selected objects depending on the objects. E.g. a number of images can be selected to touchdown and drag and together they can be moved to trash.

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Touch Screen Gestures

Touch Screen Technologies

by

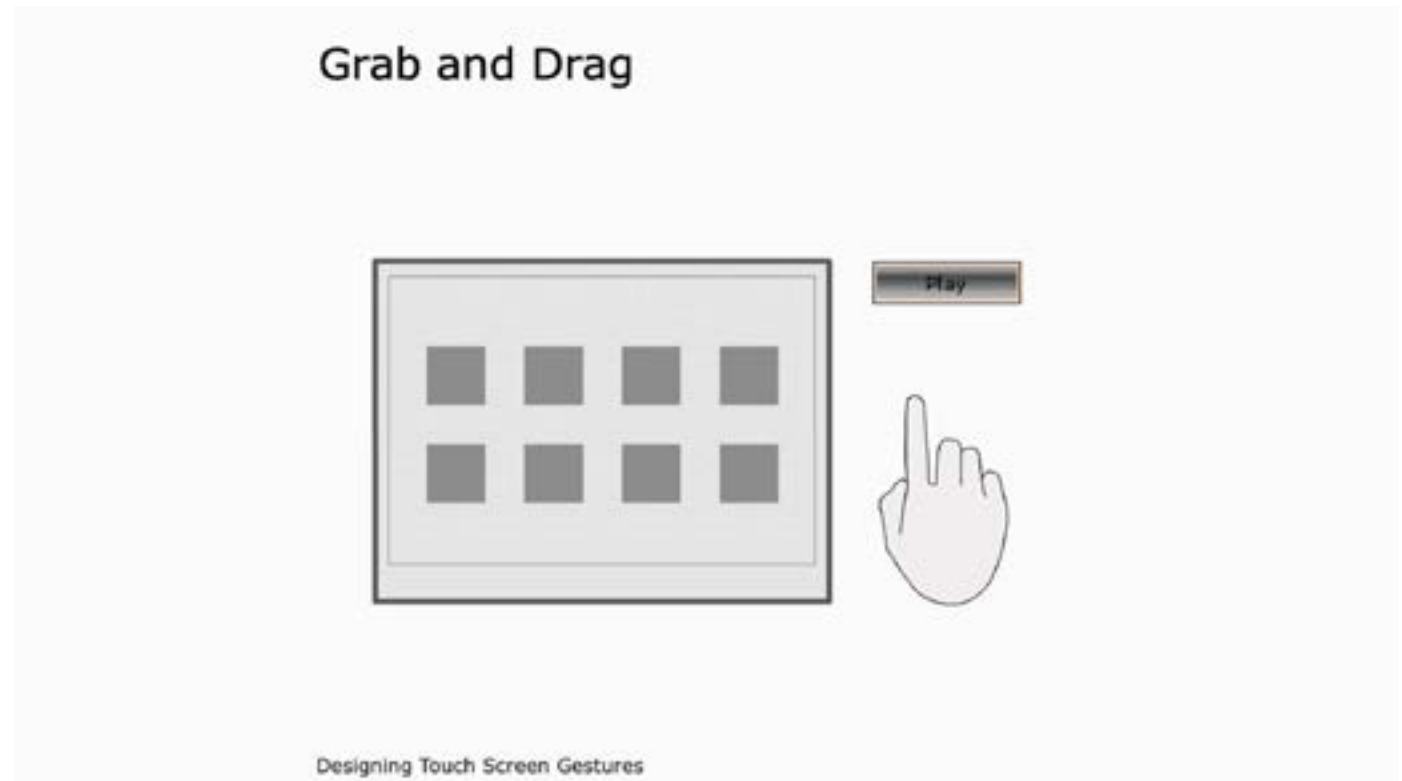
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Designing Touch Screen Gestures

Touch Down and Drag.

Touchdown and Hold:

When a number of actions are associated with the selected object, and needs to be shown to user to perform any of those actions, touchdown and hold gesture is used. It is similar to a right click on mouse based interaction.

An index finger is placed on the target object and kept on hold until the information is displayed, a set of actions are showcased to the user. User can choose the appropriate action to complete the task. It is recommended to showcase the set of action close to the fingertip, so action can be chosen easily. For example, touchdown and hold can be used to quickly edit images on a touch screen interface. User can choose target image, hold it and set of actions such as crop, blur, sharpen etc. can be showcased to the user for image editing.

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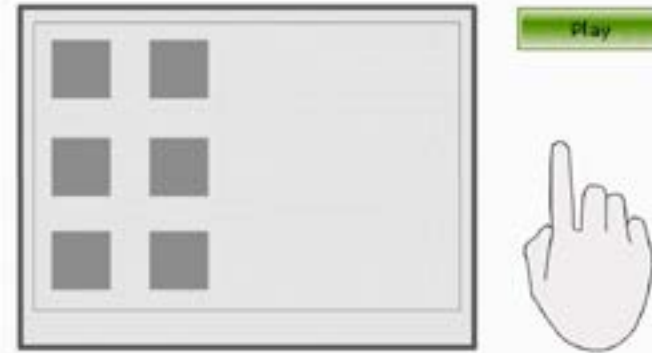
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Touchdown and Hold



Touchdown and Hold.

Slide to Scroll:

Many screens have a smaller visible area, specifically mobile devices, where all the contents are not possible to show at one go. Slide to scroll is used when user wants to see the contents that resides outside the visible screen area. For example, viewing a map, list of items that go beyond the visible screen area such as phonebook contact, messages etc.

Though this is similar to drag and drop movement, but specific to sliding a finger on the screen in one direction, that helps scroll the screen or list of the items in one direction. Slide to scroll should not be used to with two fingers to scroll for clarity purpose.

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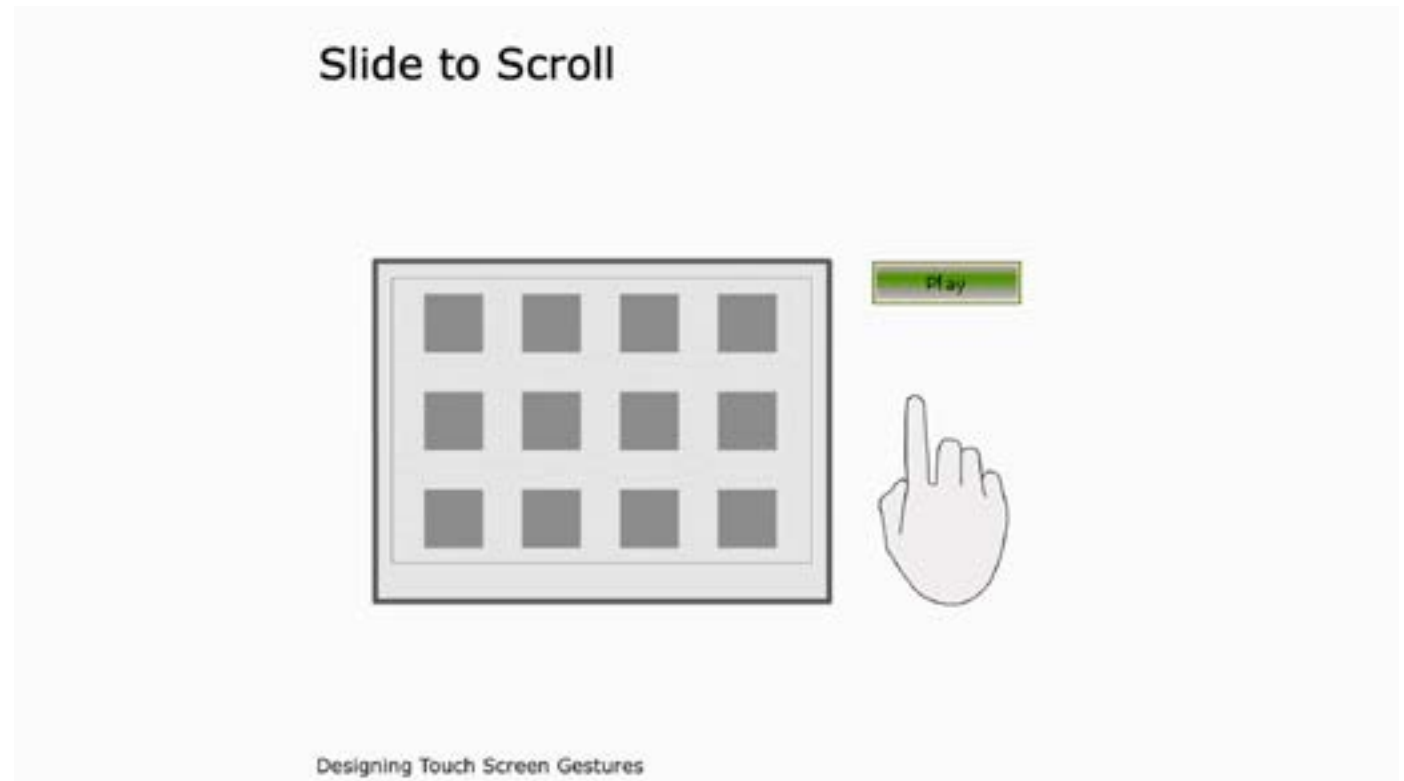
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Slide to Scroll.

Slide and Hold for Continuous Scroll:

One rotation on the scroll can go through the full list of items on the screen. A speed or time threshold can also be set so that after it is reached the scrolling can speed up.

Rapid scrolling can be difficult for users to follow, so it is best if the user understands the structure of the list. (e.g. list can be alphabetical order) It can also be difficult to precisely stop on a particular item. User often goes back and forth to select the chosen item. Scroll bar indicating position can also be helpful; either making it always visible to making it visible whenever necessary. Visual and haptic feedback can be helpful to follow the scrolling of the items. A visual feedback is also helpful such as haptic feedback, visual bounce or sound. Also it is helpful to indicate the user when he reaches to end of the scroll.

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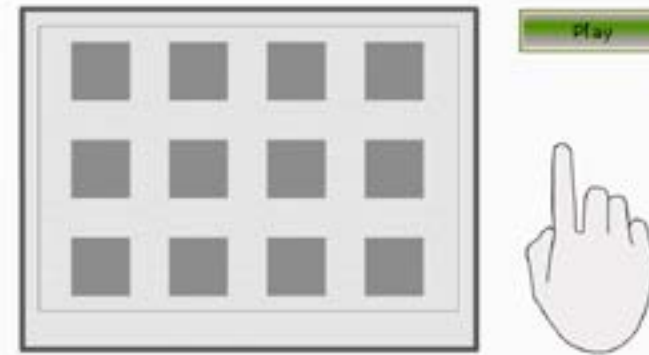
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Slide to Hold for Continuous Scroll



Designing Touch Screen Gestures

Slide and Hold for Continuous Scroll.

Spin to Scroll:

In addition to slide to scroll, spin to scroll is used to view the contents that are not visible on the screen due to smaller screen size. Typically a user moves his thumb or index finger in a circular motion to scroll. A clockwise gesture scrolls down/forward/right and a counterclockwise gesture scrolls up/backward/left. Spin to scroll can be used on touch screen as well as on a circular trackpad such as an iPod. Spin to scroll allows for rapid scrolling with a motion that is more continuous and smoother than up and down or side to side scrolling. One rotation on the scroll can go through the full list of items on the screen. A speed or time threshold can also be set so that after it is reached the scrolling can speed up. Rapid scrolling can be difficult for users to follow, so it is best if the user understands the structure of the list. (e.g. list can be in alphabetical order)

It can also be difficult to precisely stop on a particular item. The user often goes back and forth to select the chosen item. A scroll bar indicating position can also be helpful; either making it always visible to make it visible

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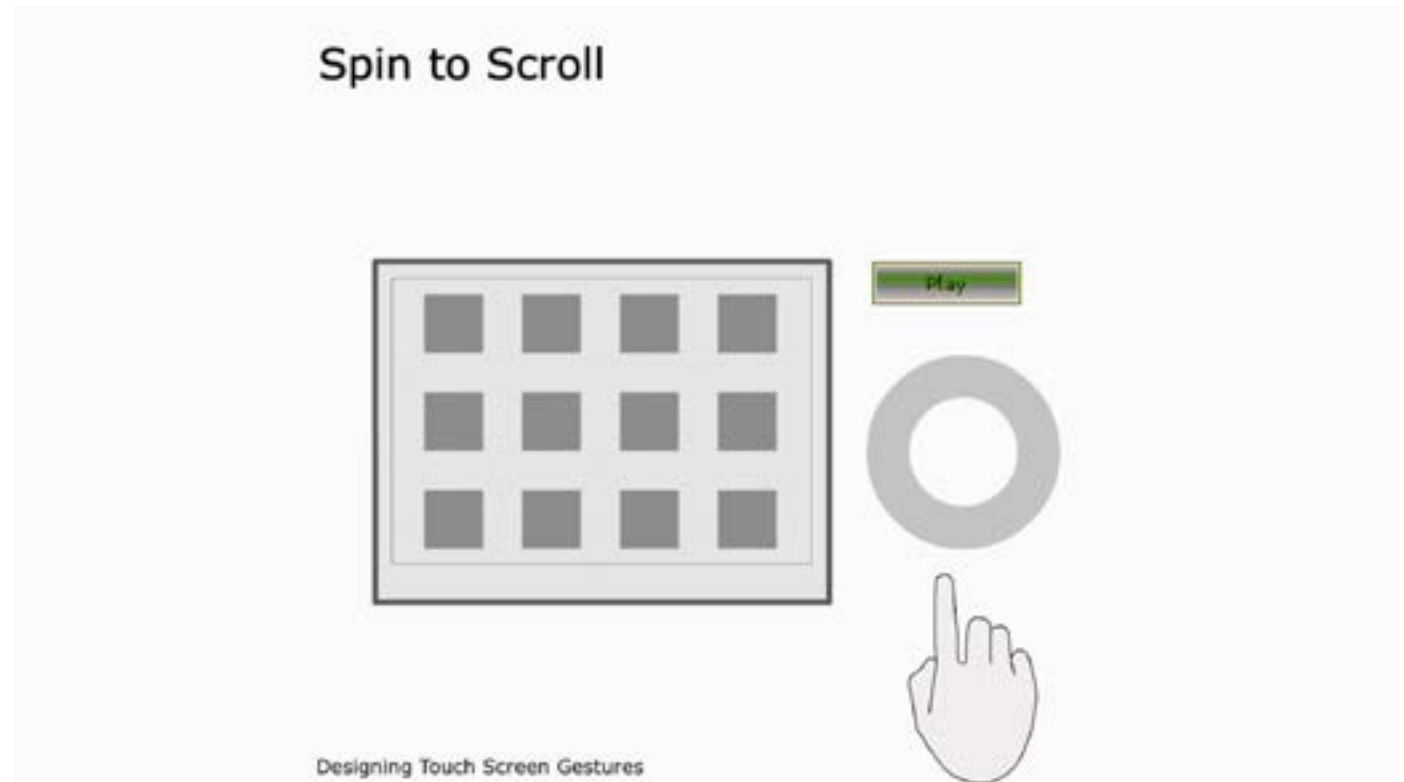
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whenever necessary. Visual and haptic feedback can be helpful to follow the scrolling of the items.



Spin to Scroll.

Fling to scroll:

In simple words, fling to scroll is a powerful version of flick. Fling to scroll is a strong fling of index finger in any direction that moves the screen in that direction. Fling to scroll is used to rapidly go through the large number of screens, contents or text. Flick and fling to scroll are natural interaction to move around the screen contents that mimics the physical world. The tip of the index finger (though it can be other fingers as well) touches the screen and moves in a straight line in one direction. The rate of the fling is translated into momentum, which is slowed and eventually stopped by simulated friction. Feedback on the gesture is very important. Feedback can be a visual bounce, haptic, sound etc.

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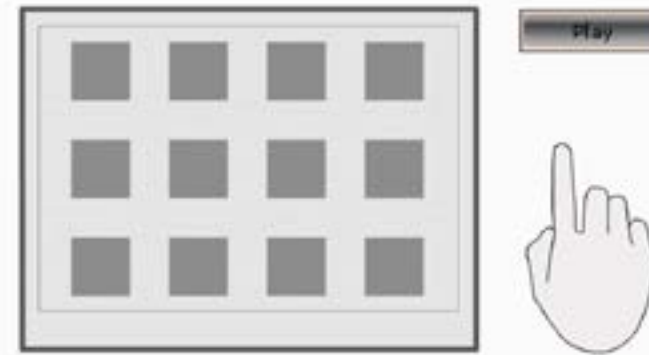
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Fling to Scroll



Designing Touch Screen Gestures

Fling to Scroll.

Two fingers to scroll:

In addition to slide to scroll, drag and drop, there is another way to go through a large amount of content or screens. Two fingers, typically an index finger and a middle finger are used to scroll through screens, a large amount of text, contents etc. Two fingers can be placed anywhere on the screen and then typically moved straight in one direction to go upward/downward/right/left.

Two fingers to scroll are generally used in trackpad (e.g. trackpad used in Apple MacBook series). Two fingers to scroll require less attention to scroll through contents as it can be placed anywhere on the screen, while slide to scroll requires conscious attention on the slider to scroll. This gesture allows control of number of elements while retaining control of individual objects via cursor. (In case of trackpad) To accommodate this gesture, the surface needs to be sensitive to two touches on the surface.

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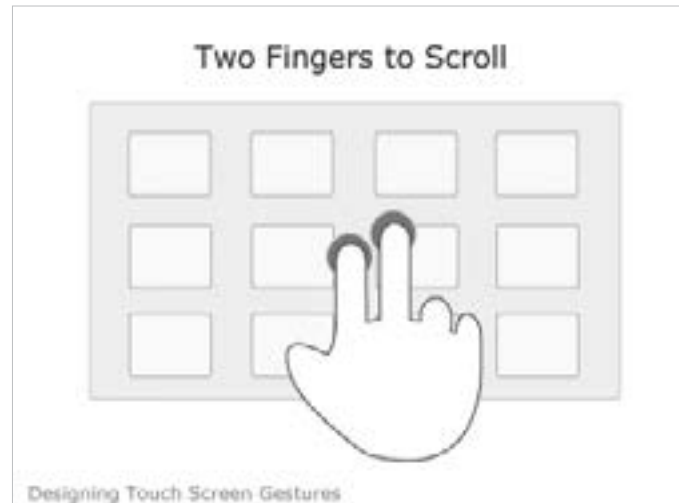
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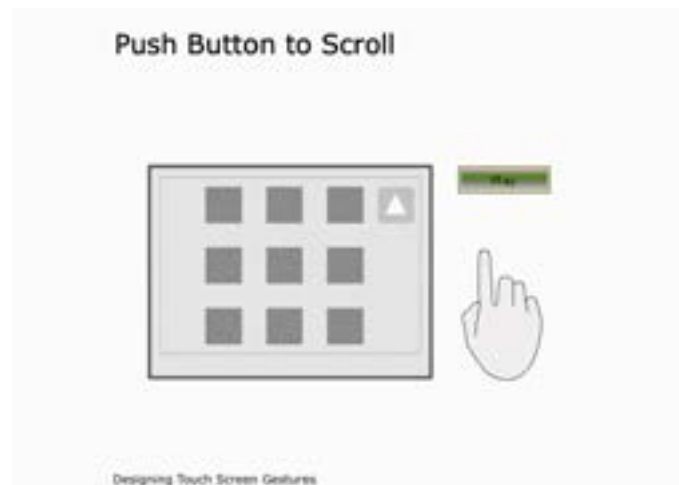
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Two Fingers to Scroll.

Push button to scroll:

In addition to drag and drop, flick and fling to scroll, another way of scrolling through large number of information can be a simple push button. A simple push button can be placed at the bottom of the screen, tapping it whenever user needs to scroll. A long time can do the scrolling faster based on time duration the button is pressed.



Push button to Scroll.

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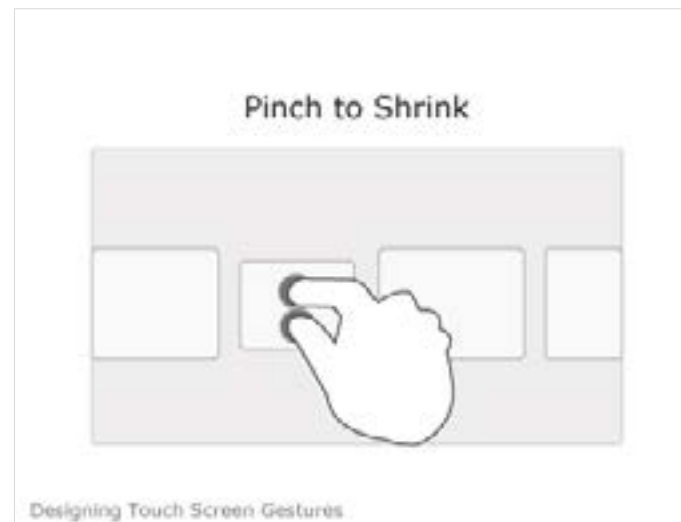
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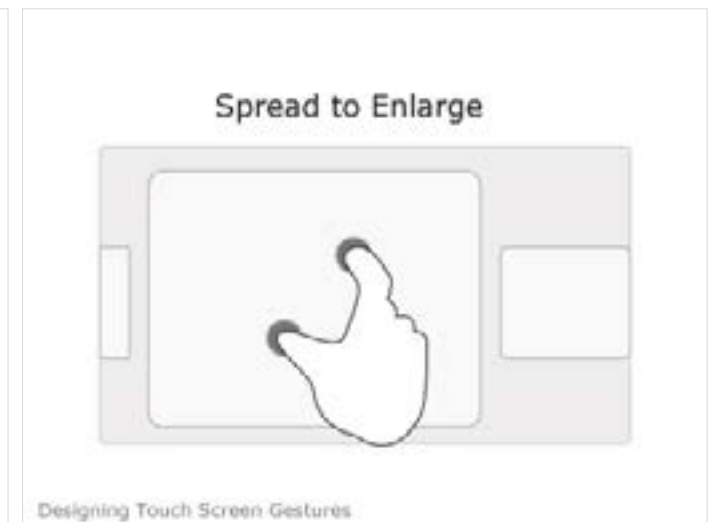
Pinch to shrink and spread to enlarge:

To check out every detail on a small touch screen device, users need to zoom in and zoom out the contents to check the details. When a document size, photograph, maps etc. need to be increased or decreased, pinch to shrink and spread to enlarge gesture is used. Two fingers, either the thumb and index finger of the same hand or index finger of both hands are used and they are brought closer together (pinch to shrink) or further apart (spread to enlarge) while on the top of the object, they decrease and increase the size respectively.

Pinch to shrink and spread to enlarge are generally found together. These two gestures require multi-touch capability as system should be able to detect two touch events on the screen. Typically elements those sizes are to be increased and decreased are scaled proportionally. The starting points of two fingers are usually equal to 100% of the object's starting size. As fingers move closer together or further apart, the element scales in real time to match the new distance between two fingers at a ratio that designers need to determine based on the sizes of the original elements and the size of the screen. e.g. if the fingers are 50% closer, the element can be 50% of its original size. Designers need to create a point beyond that users cannot shrink or enlarge the object.



Pinch to Shrink.



Spread to Enlarge.

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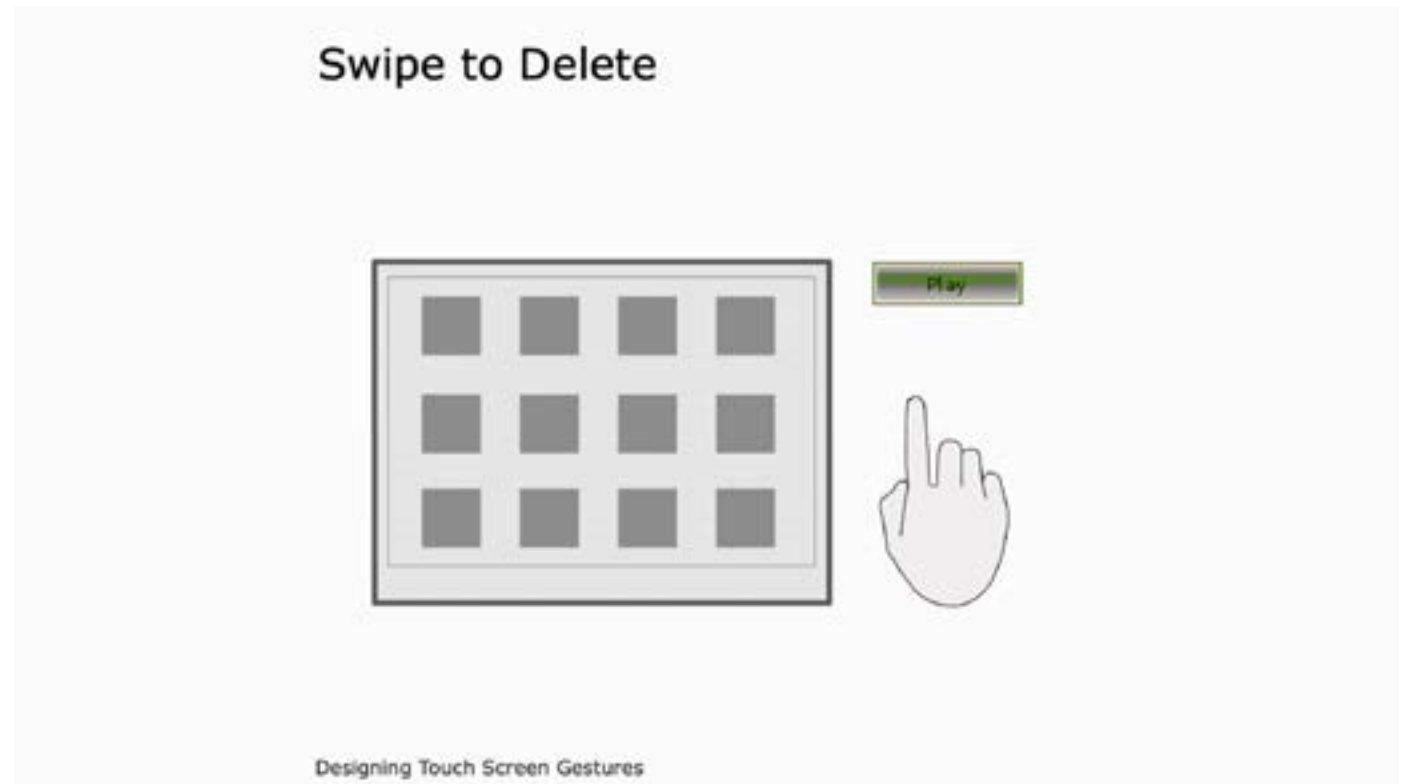
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Swipe to Delete:

In addition to selecting an object and command them to delete through a delete button, swiping the object out of the window can be used to delete the content. When a number of selected objects are to be deleted from a long list of objects, swipe method can be used. From a list of objects, user can select an object with fingertip and make a gesture to throw it out of the screen will help delete the object. Though there is a possibility, if gesture is not performed accurately, it may lead to drag and drop gestures. So appropriate care needs to be taken to design *swipe* gestures.



Swipe.

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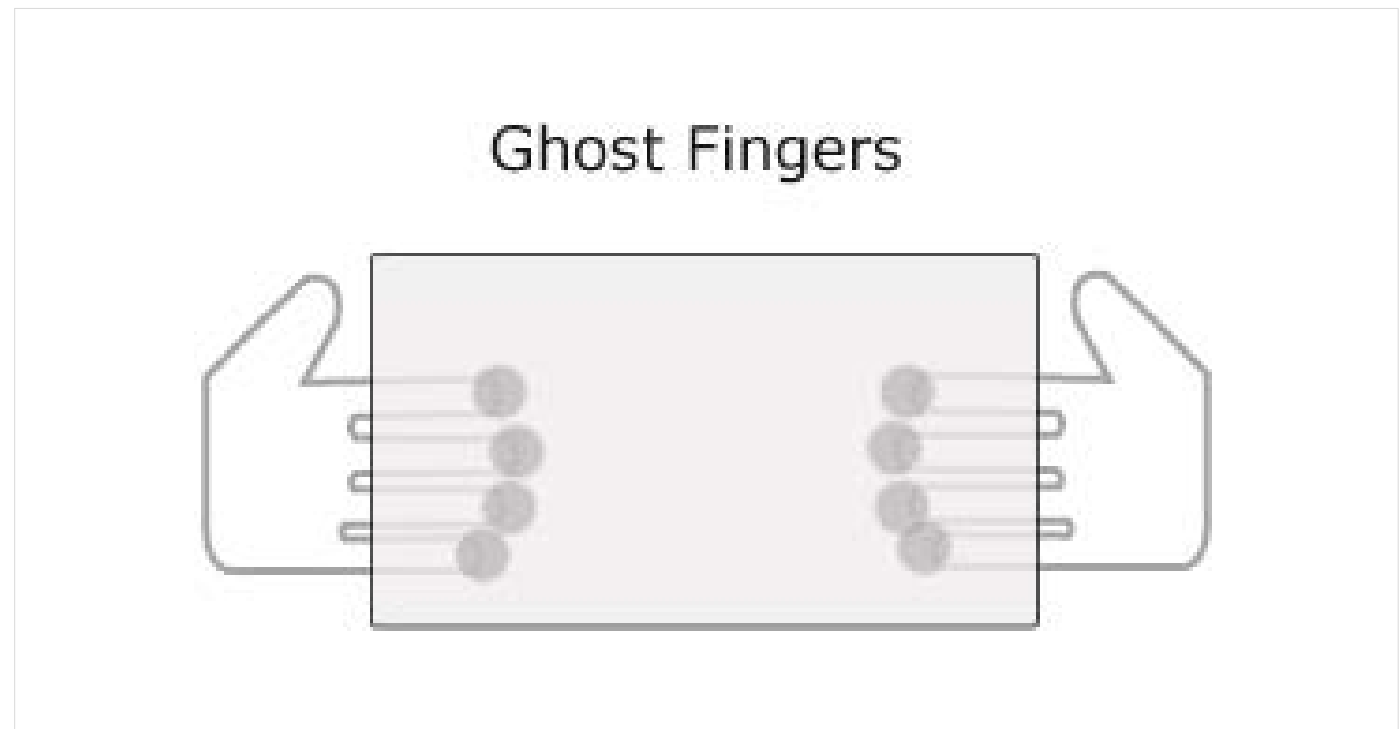
Ghost Fingers:

Ghost fingers are visualization of user's fingers when the fingers are out of users' line of sight such as on the other side of a mobile device, inside an object or on the other side of a wall.

When the user has to see her fingers to manipulate controls but prevent them from seeing because of the hardware and environment, ghost fingers are used.

Through ghost fingers you may be able to overcome the limitation of opaque surfaces and screen coverage, place controls in more ergonomic way and in places that make more sense. If the back of the device can be used, this gesture allows the use of all 10 fingers at once.

Ghost finger gesture requires sensors to detect the positioning of hands. A second touch pad or additional cameras can be added to detect the positioning of the fingers. Shadow like fingers can be used for the visualization of ghost fingers.



Ghost Fingers.

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Free Form Gestures:

In touch screen interfaces, freeform gestures can be used to upgrade personalized security measures for users. For example, a personalized freeform gesture can be incorporated to unlock the keypad and further operations for use in a touch based mobile device.

Users should be given a freedom to choose the personalized gesture, so they can better remember it. It is very essential to understand the negative side of providing freeform gestures. Proper care should be taken while giving freedom to choose a personalized gesture and there must be a way out if user forgets the gesture.

There are endless possibilities to use freeform gesture depending on the context of use, application area and content.

Other Touch Screen Gestures:

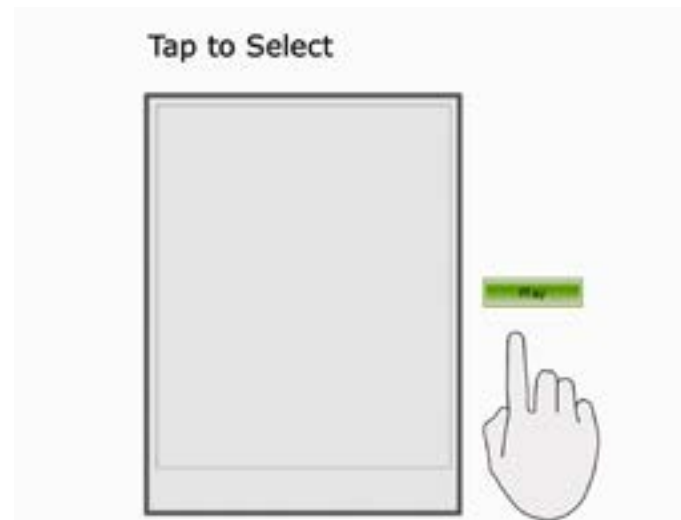
There can be a number of gestures added depending on the application & functionality of use.

For example:

- Making a cross (x) gesture to delete the content/ information.
- Identifying users with their gestures.
- Horizontal scrolling to move across number of screens and many more can be thought of.

Though while defining new gesture,

- It should be kept in mind to keep them as natural as possible.
- People should be able to relate the gesture with the action performed and result obtained.



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Touch Feedback

It is very essential for users to know whether the action has been successfully performed. A good feedback method can make touch interfaces easy to understand, learn and operate.

Types of feedback:

There are 3 types of feedback relating to touch screens:

- Visual feedback
- Sound feedback
- Haptic feedback

Visual feedback:

It includes visual bounce, color changes when action is performed, screen is moved left/ right/ up/ down, target element glows when touched, 3D motion of performed action, hourglass display to showcase waiting period etc.

Sound feedback:

When the user touches the target element, several sound feedbacks can be provided. For example, click sound, beep sound, actions can be spoken by system etc.

Haptic feedback:

A vibration effect can be provided to every touch done by a user. This will indicate user about his performed action.

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Design Consideration

- Represent the objects in recognizable way.
- Design for direct manipulation with the objects on screen. Reduce the number of objects kept hidden.
- Nails do not work for fewer touch screens, such as capacitive touch screens. Though they are more accurate than finger pad and fingertip, but in some touch screens, they may not trigger the touch event. Appropriate care should be taken while choosing the type of touch screen, especially when the target users are female.
- Typing on touch screen can be tedious and straining for wrist, especially on vertically mounted touch screens for a longer period of use. The arrangement of a keyboard may make the task of typing easier.
- Also, the height of vertically mounted, wall mounted and large size touch screens should be properly chosen to make the system easy to use. Users should not struggle (bend too much or jump) to reach the information.
- Human palm is accidentally touched to the screen, activating other elements on the interface. One solution is to make a vertical arrangement for the touch screen, which may work for interactive kiosks, but not for mobile phones.
- In an open environment used touch screens (e.g. used for city guides, bus information system at bus stops etc.) the screen gets dirty due to the environment. Appropriate care should be taken to choose the type of touch screen, casing if required, and placement of contents /actionable objects.
- During the touch screen use, the hand covers a significant space of the screen, which is not visible. Try not to put instructions, labels, and contents below the interface element that can be touched.
- Mouse based gestures may not be suitable for touch interfaces. Natural gestures are the best way to think of using new gestures for touch interfaces.
- There are environmental challenges while designing touch screen interfaces. In cold weather, people tend to wear gloves, which may require interface modifications and type of touch screen to be used.
- The aim of touch screen interfaces should be for direct manipulation. This makes the interface direct and easy to understand. If haptic feedback is not possible to accommodate, try using several iterations of visual and sound feedback. (e.g. visual bounce, color change, increase and decrease icon size, animation of one screen moving to another screen, beep sound etc.).

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- There is no hover in touch-based interfaces. It is a good idea to tell people how to touch and where to touch. Another way of looking at it is, actionable objects can be designed (size, color, shape etc.) to attract users to touch.
- The touch screen interface aims at direct manipulation. Try to avoid hidden contents.
- It can be beneficial to use a grid structure to divide the screen and provide content appropriately. E.g. the content structure on screen can be divided into display elements, input elements, keyboard section, and status display.
- Location of the structured content grid is beneficial to keep consistent for easy usage. Similar way, touch feedback can also be made consistent throughout the interface. This will help users to perceive them as unity.
- Limit the number of total screens to a smaller number.
- Input data entry such as a keyboard or numeric entry can be made available whenever required. It needs not to be all the time on the screen, especially for a longer period of use.
- It is recommended to use graphical buttons (of course, that should look like a button) to perform an action instead of using a text-based link. Though if the screen space is relatively smaller and completely character based, then text-based links can be used.
- It is recommended not to show cursor on the touch screen interfaces.
- There are two ways to have numeric entry arrangement.
 - Telephone layout
 - Keyboard layout

Telephone layout can be useful for users as they can relate the numeric entry with other existing telephones. Especially when numeric entry is designed for calling purposes.

Keyboard layout can be useful for user who is known to use keyboard and its numeric layout, though it may not be a good idea to accommodate the same calling purpose.

Positively, It provides an opportunity for designers to brainstorm natural gestures that can be used for touch-based systems. If the target size of the element is small, finger precision can be a worry and be less accurate.

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More details about his research can be found on www.embeddedinteractions.com

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