**Introduction:**

A touchscreen is an input device that allows users to operate a PC by simply touching the display screen. Touch input is suitable for a wide variety of computing applications. A touchscreen can be used with most PC systems as easily as other input devices such as track balls or touchpads.

A Touch screen is an electronic visual display that can detect the presence and location of a touch within the display area. The term generally refers to touching the display of the device with a finger or hand. Touch screens can also sense other passive objects, such as a stylus. A touch screen is based on CRT (Cathode Ray Tube) technology, which accepts direct onscreen input.

Touch screens best suit applications that require frequent interaction with non-technical users or must work in dirty environments. The devices are easy to use and can tolerate dirt and moisture that would quickly disable a keyboard or a mouse. Some Touch screens can work through a 2-inch thick barrier. This feature can protect both the system from user abuse and the user from the system’s environment. Compact designs can also benefit from touch screen technology. Because Touch screens are integral to the display device, the screens eliminate the need for a separate keypad. You can make hand-held devices with Touch screens as small as the display itself.

The touch screen has two main attributes. First, it enables one to interact directly with what is displayed, rather than indirectly with a cursor controlled by a mouse or touchpad. Secondly, it lets one do so without requiring any intermediate device that would need to be held in the hand. Such displays can be attached to computers, or to networks as terminals. The ability for direct onscreen input is facilitated by an external (light pen) or an internal device (touch overlay and controller).
They also play a prominent role in the design of digital appliances such as the personal digital assistant (PDA), satellite navigation devices, mobile phones, and video games.

**How Does a Touch screen Work?**

A basic touch screen has three main components: a touch sensor, a controller, and a software driver. The touch screen is an input device, so it needs to be combined with a display and a PC or other device to make a complete touch input system.

1. **Touch Sensor**
A touch screen sensor is a clear glass panel with a touch responsive surface. The touch sensor/panel is placed over a display screen so that the responsive area of the panel covers the viewable area of the video screen. There are several different touch sensor technologies on the market today, each using a different method to detect touch input. The sensor generally has an electrical current or signal going through it and touching the screen causes a voltage or signal change. This voltage change is used to determine the location of the touch to the screen.

2. Controller

The controller is a small PC card that connects between the touch sensor and the PC. It takes information from the touch sensor and translates it into information that PC can understand. The controller is usually installed inside the monitor for integrated monitors or it is housed in a plastic case for external touch add-ons/overlays. The controller determines what type of interface/connection you will need on the PC. Integrated touch monitors will have an extra cable connection on the back for the touchscreen. Controllers are available that can connect to a Serial/COM port (PC) or to a USB port.

3. Software Driver
The driver is a software update for the PC system that allows the touchscreen and computer to work together. It tells the computer's operating system how to interpret the touch event information that is sent from the controller. Most touch screen drivers today are a mouse-emulation type driver. This makes touching the screen the same as clicking your mouse at the same location on the screen. This allows the touchscreen to work with existing software and allows new applications to be developed without the need for touch screen specific programming. Some equipment such as thin client terminals and specialized computer systems either do not use software drivers or they have their own built-in touch screen driver.

TOUCH SCREEN DIVERSITY:

Four-Wire Resistive Touch screen:

The x and y coordinates of a touch on a 4-wire touch screen can be read in two steps. First, Y+ is driven high, Y- is driven to ground, and the voltage at X+ is measured. The ratio of this measured voltage to the drive voltage applied is equal to the ratio of the y coordinate to the height of the touch screen. The y coordinate can be calculated. The x coordinate can be similarly obtained by driving X+ high, driving X- to ground, and measuring the voltage at Y+. The ratio of this measured voltage to the drive voltage applied is equal to the ratio of the x coordinate to the width of the touch screen. This measurement scheme can be seen in figure.
Five-Wire Resistive Touch screen:

5 wire resistive touch screen features unrivaled accuracy, reliability, superior light transmission, highest touch point density, touch input variety. Impervious to environmental conditions such as liquid splashes, contamination. The lifetime is up to 35 million finger touches, much better than 4 wire resistive touch screen.

Resistive Touch screen:

Resistive touch screens are composed of two flexible sheets coated with a resistive material and separated by an air gap or microdots. When contact is made to the surface of the touch screen, the two sheets are pressed together. On these two sheets there are horizontal and vertical lines that when pushed together, register the precise location of the touch. Because the touchscreen senses input from contact with nearly any object (finger, stylus/pen, palm) resistive touchscreens are a type of "passive" technology.
For example, during operation of a four-wire touchscreen, a uniform, unidirectional voltage gradient is applied to the first sheet. When the two sheets are pressed together, the second sheet measures the voltage as distance along the first sheet, providing the X coordinate. When this contact coordinate has been acquired, the uniform voltage gradient is applied to the second sheet to ascertain the Y coordinate. These operations occur within a few milliseconds\textsuperscript{[1]}, registering the exact touch location as contact is made.

Resistive touchscreens typically have high resolution (4096 x 4096 DPI or higher), providing accurate touch control. Because the touchscreen responds to pressure on its surface, contact can be made with a finger or any other pointing device.

Resistive touch screen monitor is composed of a flexible top layer and a rigid bottom layer separated by insulating dots, attached to a touch screen controller.

The inside surface of each of the two layers is coated with a transparent metal oxide coating. Pressing the flexible top sheet creates electrical contact between the resistive layers, producing a switch closing in the circuit.
The controller gets the alternating voltages between the two layers and converts them into the digital X and Y coordinates of the activated area.

**The Surface Acoustic Wave (SAW) technology:**

The Surface Acoustic Wave (SAW) technology is one of the most advanced touch screen types. The technology is based on two transducers (transmitting and receiving) placed for the both of X and Y axis on the touch panel. The other important element of SAW is placed on the glass, called reflector. The controller sends electrical signal to the transmitting transducer, and transducer converts the signal into ultrasonic waves and emits to reflectors that are lined up along the edge of the panel. After reflectors refract waves to the receiving transducers, the receiving transducer converts the waves into an electrical signal and sends back to the controller. When a finger touches the screen, the waves are absorbed, causing a touch event to be detected at that point.

Compared to Resistive and Capacitive technologies, SAW technology provides superior image clarity, resolution, and higher light transmission. Because the panel is all glass, there are no layers that can be worn, giving this technology the highest durability factor and also the highest clarity. Disadvantages of Surface Acoustic Wave (SAW) technology include the facts that the touch screen must be touched by finger, gloved hand, or soft-tip stylus (something hard like a pen won't work) and that the touchscreen is not completely sealable, can be affected by large amounts of dirt, dust, and or water in the environment.

The Surface Acoustic Wave technology is recommended for ATMs, Amusement Parks, Banking and Financial Applications, public information kiosks, computer based training, or other high traffic indoor environments.
Capacitive Touch Screen Technology:

The touchpad contains a two-layer grid of electrodes that are connected to a sophisticated full-custom mixed signal integrated circuit (IC) mounted on the reverse side of the pad. The upper layer contains vertical electrode strips while the lower layer is composed of horizontal electrode strips. The IC measures "Mutual capacitance" from each of the horizontal electrodes to each of the vertical electrodes. A human finger near the intersection of two electrodes modifies the mutual capacitance between them, since a finger has very different dielectric properties than air. When a user touches the screen, some of the charge is transferred to the user, and makes the potential difference on the screen. After the panel controller recognizes that, the controller will send the X-Y axis information to the PC port.

The advantage is that capacitive technology transmits almost 90% percent of the light from the screen. The superior efficiency gives capacitive better than resistive technology.
Surface Capacitive:

Surface capacitive touch technology is one of the most established touch interfaces available today. Pioneered by MicroTouch Systems in the mid-1980s, surface capacitive technology is the preferred solution for public-access applications in contaminant-prone environments. It has a uniform conductive coating on a glass panel.

During operation, electrodes around the panel’s edge evenly distribute a low voltage across the conductive layer & creates an uniform electric field. A finger touch draws current from each corner. Then the controller measures the ratio of the current flow from the corners and calculates the touch location.

Projected Capacitive Touch screen:
3 layers: front and back protective glass provides optical and strength enhancement options & middle layer consists of a laminated sensor grid of micro-fine wires. During a touch, capacitance forms between the finger and the sensor grid. The embedded serial controller in the touch screen calculates touch location coordinates and transmits them to the computer for processing.
Near Field Imaging Touch screen:

Touch-screen technology has long been used for indoor applications, but strong sunlight and extreme weather is too hard on the electronics. Engineers at 3M Touch Systems, Methuen, Mass,(www.3m.com/3mtouchsystems/), have developed a new integrated touch screen, the Microtouch Near Field Imaging screen, that features solar-reflecting film sandwiched between two glass layers. The nonmetallic film reflects rather than absorbs infrared solar energy while letting visible light pass through, thus keeping the electronics and LCD inside cooler and less prone to failures. The glass layers include a top, protective cover, and the bottom sensor plate. The sensor plate has a patterned coating of transparent metal oxide. An ac signal applied to the conductive coating creates an electrostatic field on the screen surface. A finger or conductive stylus touching the screen surface disturbs the electrostatic field, and the touch and its location are registered. The screens work even if users wear gloves, or have moisture, gels, and other contaminants on their hands. The screen's glass construction lets it operate despite scratches, pits, and other surface damage from abrasives, chemicals, and vandals.
Infrared Touch screen:

The infrared light beams emitted by LED pairs form an invisible grid on the surface of glass.
Infrared technology uses infrared emitter-collector pairs to project an invisible grid of light a small distance over the surface of the screen. When a beam is interrupted, the absence of the signal at the collector is detected and converted to an X/Y touch coordinate.

IR touch screen instantly turns LCD/PLASMA/front/rear projection monitor into interactive display. Unlike most other technologies, the Infrared based design offers superb image clarity. The original image quality is preserved because there is no film in front of the display. After a simple installation, the screen can be operated with either a finger, with or without glove or a pen. Infrared technology can scale in size up to 100" in diagonal. Features like no drift, scratch proof, water proof, dust proof, sunlight operability present the IR touch screen an ideal choice for interactive presentation, classroom whiteboard, command center, public venue kiosks, info center directory, and many other interactive applications.

Touch Screen Technology Comparison:
There are many widely used touchscreen technologies. Each type of screen has unique characteristics that can make it a better choice for certain applications. To follow is a brief description of the 4 most common technologies.

4-Wire Resistive Touchscreens

4-Wire Resistive touchscreen technology is a reliable and affordable technology that is widely used by individuals and in less demanding workplace applications. It is pressure sensitive so it responds to any input device, including finger, gloved hand, or pen stylus. Follow this link for more information.

5-Wire Resistive Touchscreens

5-Wire Resistive touchscreen technology is used with both CRT and LCD touch monitors. It is a durable and accurate technology that is widely used in demanding workplace applications such as point-of-sale systems, industrial controls, and medical systems. It is pressure sensitive so it responds to any input device, including finger, gloved hand, or pen stylus. Follow this link for more information.

Capacitive Touchscreens

Capacitive touchscreen technology is used with both CRT and LCD touch monitors. It is a durable technology that is used in a wide range of applications including point-of-sale systems, industrial controls, and public information kiosks. It has a higher clarity than Resistive technology, but it only responds to finger contact and will not work with a gloved hand or pen stylus. Follow this link for more Information.

Surface Acoustic Wave Touchscreens
Surface Acoustic Wave touchscreen technology is also used with both CRT and LCD touch monitors. It is a very durable screen that is widely used in applications such as computer-based training and information kiosk displays. It is a good choice for applications where image clarity is important, but it may not perform well in extremely dirty or dusty environments. Responds to finger or soft rubber tipped stylus.

<table>
<thead>
<tr>
<th>Product</th>
<th>Four-Wire Resistive</th>
<th>Five-Wire Resistive</th>
<th>Pen Touch</th>
<th>Capacitive</th>
<th>Surface Wave (Saw)</th>
<th>Infrared Touch (Ir)</th>
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</thead>
<tbody>
<tr>
<td><strong>PRODUCT SIZE</strong></td>
<td>1.7&quot; - 24&quot;</td>
<td>10.4&quot; - 24&quot;</td>
<td>15&quot; - 19&quot;</td>
<td>12&quot; - 24&quot;</td>
<td>10.4&quot; - 30&quot;</td>
<td>10.4&quot; - 42&quot;</td>
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<td><strong>TOUCH LIFE</strong></td>
<td>1 - 2 million touches</td>
<td>30 - 35 million touches</td>
<td>100 million touches</td>
<td>100 million touches</td>
<td>50 million touches</td>
<td>Long-term reliability</td>
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<td><strong>RESOLUTION</strong></td>
<td>4096x4096</td>
<td>1024x1024</td>
<td>1024x1024</td>
<td>1024x1024</td>
<td>4096x4096</td>
<td>4096x4096</td>
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<tr>
<td><strong>LIGHT TRANSMISSION</strong></td>
<td>81%</td>
<td>81%</td>
<td>93%</td>
<td>93%</td>
<td>90%</td>
<td>90%</td>
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<tr>
<td><strong>SCRATCH RESISTANCE</strong></td>
<td>Hard Coated</td>
<td>Hard Coated</td>
<td>Hard Coated (SIO²⁺)</td>
<td>Hard Coated (SIO²⁺)</td>
<td>Glass Overlay Moh's hardness rating of 7</td>
<td>Glass Overlay Moh's hardness rating of 7</td>
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<tr>
<td><strong>CONTAMINANT RESISTANCE</strong></td>
<td>Resists moisture, dirt, vinegar, ammonia based food products and cleansers</td>
<td>Resists moisture, dirt, vinegar, ammonia based food products and cleansers</td>
<td>May be affected by vinegar, ammonia based food products and cleansers</td>
<td>May be affected by vinegar, ammonia based food products and cleansers</td>
<td>Resists moisture, dirt, vinegar, ammonia based food products and cleansers</td>
<td>Resists moisture, dirt, vinegar, ammonia based food products and cleansers</td>
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<td><strong>INPUT METHOD</strong></td>
<td>Finger, Gloved Hand, Stylus</td>
<td>Finger, Gloved Hand, Stylus</td>
<td>Stylus Pen</td>
<td>Finger</td>
<td>Finger, Gloved Hand, Soft pliable stylus</td>
<td>Finger, Gloved Hand, Stylus</td>
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<td>5 years</td>
<td>10 years</td>
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<td>IP65</td>
<td>IP64</td>
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</table>

**Applications:**
Public Information Displays
Tourism displays, Trade show display
Customer Self-Services Stores
Restaurants
ATMs
Airline ticket terminals and Transportation hubs
Digital jukeboxes
Computerized gaming
Student Registration systems
Multimedia softwares
Scientific applications etc.

Conclusion:

Touch screen technology will increase in significance as an I/O technique for user oriented embedded systems. Vendors have been steadily reducing or eliminating the weaknesses in touch sensors as well as adding new capabilities.

This combination of steady improvement punctuated by innovation will continue to broaden the range of applications that touch screens can serve. With these improvements, touch screen technology has become a viable user interface for many embedded systems. The inclusion of electronic ink services in Windows 9x indicates that touch screens will become a dominant interface. You need only to carefully match the technology to the application environment.

Though the touch screen technology contains some limitations it’s very user friendly, fast, accurate, easy for the novices & fun to operate. It has been widely accepted. And now by just modifying a little it can replace the mouse and keyboard completely in near future.

References:
en.wikipedia.org/wiki/Touchscreen