World of Touch Screen

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***Abstract*- This document is about touch screen which is a computer display screen that is also an input device. Where the screens have become an indispensable part of life, not many know about it. Earlier people used to work with keypad type system. The pointof this research paper is a study of different technologies of touch screen and their working. It took technological advancement and several generations to achieve this presence.**

***Index terms*- Touchscreen, Capacitive, Resistive, Surface Acoustic Wave, Infrared, Optical and 3-D technology**

I.INTRODUCTION

The touch screen is an electronic visual display that does the detection of gestures within the display area and then accurately locating the point. It is a computer display screen that serves as an input/output device which accepts directly from the monitor where the user touches words, graphical icons, or symbols displayed on the screen to activate command. It can be a single touch or multi-touch gesture on the screen which registers the event and sends it to the controller for processing.

The gesture can be produced by special stylus or fingers. Some screens use specially coated gloves to work.

Its advantages are that the user gets to interact with what is displayed directly and does not require intermediate devices to do so like a mouse.

II. HISTORY

In a piece of writing published in 1967, Eric Johnson, of the Royal Radar Establishment, in Malvern, England, described his work on capacitive touchscreens with photographs and diagrams. On October 7, 1975, a resistive touchscreen was developed by American inventor George Samuel Hurst. The first version was produced in 1982. In 1972, a gaggle at the University of Illinois filed for a patent on an optical touchscreen.

1 In 1983, Myron Krueger introduced Video Place. Which can track hands, fingers, and the people they belong to. Also HP releases the HP-150, one of the first touch screen computers.
2 In 1984, Bob Boie of Bell Labs officially developed the first multitouch screen overlay.
3 In 1993, Apple released its touch-capable newton PDA.
4 In 1999, Wayne Westerman and John Elias formed FingerWorks that specialized in multi-gesture input devices.
5 In 2002, Sony's SmartSkin introduced mutual capacitive touch recognition.
6 In 2006. Jeff Han introduced an interface free, touch driven computer screen at TED.
7 In 2008 Microsoft introduced the Surface table which is an interactive surface computing platform which allows one or more people to use and touch real-world objects. Users can also share digital content at the same time.

III. BASIC WORKING OF TOUCH SCREEN TECHNOLOGY

There are a lot of different technologies out there but they're all trying to achieve the same goal: sending precise electrical signals from specific locations on the screen.

They have mainly five components:-
1. Front panel or Bezel
2. Touch Controller
3. Touch sensor
4. Liquid Crystal Display
5. Software driver

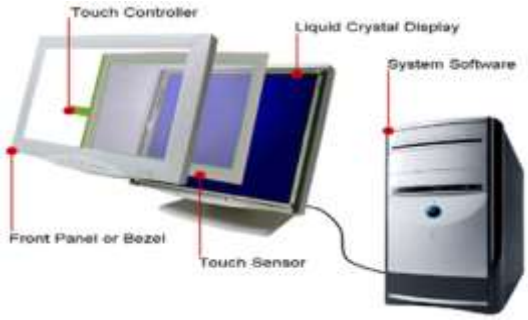

Fig. 1 Touchscreen controller autopsy

A. Front panel or Bezel

Front panel or Bezel is the outermost skin of the product. In some products, this bezel acts as a protective layer that keeps weather and moisture out of the system and also resists scratching and vandalism to the underlying sensor technology. But in other cases, bezel just covers the edge of the underlying touch sensor; in that case, it is purely decorative.

B. Controller

A controller is connected between the touch sensor and PC which takes information from the sensor and translates it for understanding of the PC. The controller determines what type of connection is needed.

C. Touch screen

A touch screen sensor may be a clear glass panel with a responsive surface. It has an electrical current/ signal through it and touching the screen causes a change in signal. This change is used to calculate the coordinates.

D. Liquid Crystal display

Most touch screens generally work over LCDs. LCDs provide clarity, resolution, refresh speed and less cost. Main reason why LCD is considered is electrical emission. The technology in touch sensors is predicated on small electrical changes when the panel is touched an LCD that emits tons of electrical noise are often difficult to design around.

E. Software driver

It allows computers and touch screens to figure together. It tells the Operating System how to interact with the event info that is sent by the controller.

IV. MULTI TOUCH

Multi-touch, during a computing context, is an interface technology that permits input through pressure and gestures on multiple points on the surface of a tool. Although most ordinarily used with touch screens on handheld devices, like smartphones and tablets, multi-touch has been adapted for other surfaces also , including touch pads and mice, whiteboards, tables and walls.

Fig. 2 Multitouch Screen

A. Examples of multi-touch include:

- Typing on a software keyboard as on a hardware one, with keyboard shortcuts, capitalization and other elements that require multiple key presses simultaneously.
- Bringing fingers together in a pinching movement on an image to zoom out or opening them from a pinched position to zoom in.
- Holding fingers apart and moving them in a clockwise motion to rotate an image in that direction.
- Reshaping an object in a touch screen display as you would a real-life object.
- Flicking a finger on the corner of a display to turn a page in an e-Reader.

B. Basic explanation of how multi-touch screen works:

Capacitors within the external layer are identified consistent with their coordinates. When touched by a finger, each capacitor sends a sign to the processor. Interpretive software takes the data and calculates the situation, size and shape or pattern of any touches on the screen. A gesture recognition program takes that

data. It uses that in conjunction with information about the application the user was running to match the touch information to a specific gesture. If a match is found, the result is relayed to the application as a command. If no match is found, the touch is considered to be unintentional and is ignored.

V. VARIOUS TECHNOLOGIES

- Capacitive Touch-screen Technology.
  - Surface Capacitance Technology
  - Projected Capacitance Technology
- Resistive Touch-screen Technology.
- Surface-Acoustic Wave Technology
- Infra-red Touch-screen Technology.

A. Resistive Touch Technology

In this type the user has to physically push and bend the screen to make it work. They are made of two layers: 1) The top layer is made from a flexible and transparent material, such as polyethylene (polythene); 2) The bottom layer is made of something more rigid, like a sheet of glass. To make the screen work, both of these layers are thinly coated with some sort of conducting metal compound, like Indium Tin Oxide, which is commonly used as it is transparent. These layers are separated by tiny dots, which don't conduct electricity, called spacers. They keep the screen apart so that there are no false touch signals.

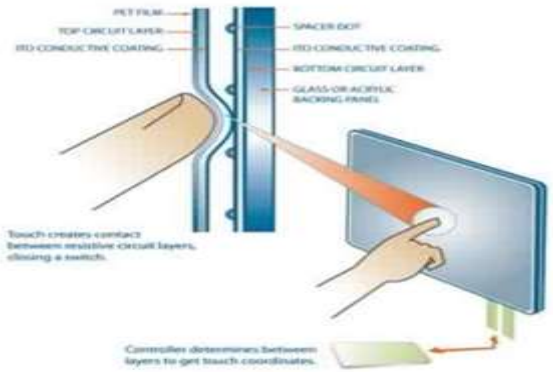

Fig. 3Working of resistive touch technology

When the screen is on a voltage is applied across the screen in both horizontal and vertical direction. As soon as the user pushes down the flexible screen by an object such as a fingertip or stylus tip, it connects the two layers. This changes the voltage and is sent to a controller and software driver to calculate exactly where the user presses in X and Y coordinates.

They are durable and affordable. But sometimes it has to be pressed hard enough and they normally can't understand multiple touches.

These systems transmit only 75% of brightness from the monitor. The resistive touch screen is further divided into 4-, 5-, 6-, 7- and 8-wired resistive touch screen. While the constructive design of these modules is analogous there's a serious distinction in each of its methods to work out the coordinates of touch.

B. Capacitive technology

A Capacitive touch-screen panel consists of an insulator like glass, coated with a transparent conductor like indium tin oxide (ITO). As the physical body is also an electrical conductor, touching the surface of the screen leads to a distortion of the screen's electric field , measurable as a change in capacitance.

Capacitive touch screens are made from single or multiple layers of fabric that are coated with a conductor like Indium Tin Oxide. A protective covering seals the assembly far away from the environment.

When another electrical conductor, sort of a bare fingertip or a stylus, touches the surface, an electrical circuit is completed at that location. Sensors embedded within the glass then detect the position of the flow of current, which is then registered as touch event.

1) Capacitive touch technology can be divided into:

- Surface Capacitive – In this only one side is coated with a transparent conductive layer. A uniform electrostatic field is created by applying a small voltage to the layer. When the uncoated surface is touched, a capacitor is dynamically formed. The sensor's controller can determine the position of the touch indirectly from the change within the capacitance as measured from the four corners of the panel.
- Projected Capacitive – In this a grid containing a grid of hair thin lines of conductive metal. The grid lines in one direction are called driving lines, which provide a constant current and the lines in the other direction are called the sensing lines, which detect this electric current. At every

point where the sensing lines and therefore the driving lines cross there'll be a selected electric field, which is registered as neutral by the processor in smartphone or computer. But that all changes when something conductive comes along and touches it like a finger. Human body can conduct electricity and can also store charge. So when the finger touches the screen, the charge on the screen is drawn around that point, distorting that electrostatic field. The electricity doesn't actually flow through the finger. The electrostatic field feels the effect of your electric charge and redistributed itself accordingly. Even really small changes are detected by the processor, which can then interpret the patterns like tap or slide.

- They are super conductive hence super responsive. They do not work with gloves because they are not conductive and sweat can affect how electricity is conducted.

2) Pros of Capacitive Touch Screens:

- Can support multi touch gestures like flick, pinch and swipe
- Are durable and robust; up to a point
- Last longer because there are no moving parts
- Are sensitive and even a light-weight touch can register an input
- Are highly responsive

C. Surface acoustic wave technology

Surface acoustic wave (SAW) technology uses ultrasonic waves that skip the touch screen panel. When the panel is touched, some portion of the wave is absorbed. The change in ultrasonic waves is processed by the controller to work out the position of the touch event. Surface acoustic wave touch screen panels can be damaged by outside elements. Contaminants on the surface also can interfere with the functionality of the touch screen.

Surface Wave Acoustic (SAW) technology operates by tracking sound waves above the human hearing range, also referred to as ultrasonic waves, to detect the position of touch points on the screen. This technology is perimeter-based, such as Infrared and Optical touch technology, but uses sound instead of light for its calculations.

1) How does it work?

A SAW touch screen is formed from a glass sheet with three components: transmitting transducers, receiving transducers, and reflectors. The transmitting transducers produce ultrasonic waves that skim over the surface of the screen, get reflected and are captured by the receiving transducers.

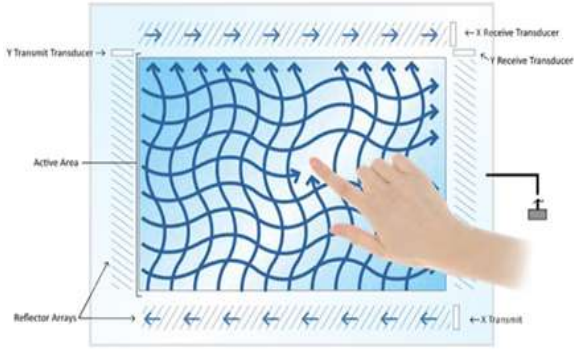

Fig. 4Working of surface acoustic wave technology

When a soft matter like human skin touches the screen, the surface acoustic waves are absorbed, and therefore the receiving transducers don't register any input. Based on this lack of sound the sensors can calculate the position of the touch event.

2) Limitations of SAW Touch Screens:

- Do not function with a pen or the other hard material
- High multi-touch latency
- Can malfunction when dirt, oil, or droplets stick on the screen
- Perimeter can't be sealed from the environment and then attracts buildup in bezel

D. Infrared technology

Infrared touch screens have a grid -like array of LED lights and photo detectors (sensors) around the edges of the device. These LED beams cross one another in vertical and horizontal patterns. This helps the sensors devour the precise location of the touch. When the surface is touched, it creates a disturbance in this light. Infrared touch screens operate by calculating light-beam interruption, or "beam break", to work out the situation of touch events. The device can then look to work out where this disturbance occurred; thus, allowing it to spot the precise point of contact. As the LED's make a grid, that results in X and Y coordinates.

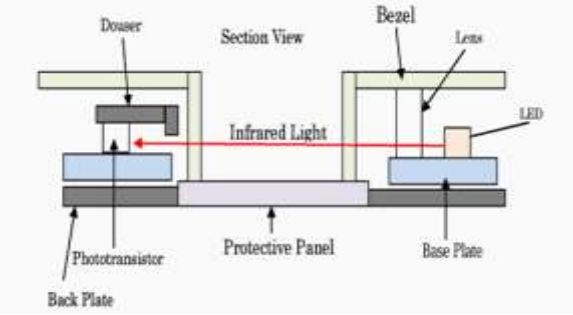

Fig. 5Working of infrared technology

As no patterning on glass is required, the optical clarity and durability increases. They are sensitive to dust and dirt and they can interfere with the infrared beam.

1) Optical technology

Optical touch screens also use infrared light, similar to infrared touch screen technologies, but the layout of the emitters and sensors is what differentiates it.

Most optical touch screens use two cameras placed in the corners at the top of the screen. These cameras are wont to look out on the whole touch surface for touch events. When an object touches the screen, it blocks a number of the sunshine being received by the sensors within the cameras. The location of the touch is then calculated by using the information from both cameras and the mathematical principles of triangulation.

VI. 3-D TECHNOLOGY

Below the screen have many small sensors, called capacitive sensors. These sensors detect the pressure of the touch to differentiate between a tap to deep press. Force touch has 2 pressure points but 3-D touch has 3 pressure points: a traditional tap, deep press and lightweight press. When the screen is pressed it opens the menu like right clicking on a computer or laptop.


Fig. 6 3-D Technology

Apple launched 3-D technology iPhone 6s and 6s Plus. 3D Touch has been developed to work using capacitive technology while sensors are integrated into the display.

VII. FUTURE SCOPE OF TOUCH SCREEN

Initially, touch screens would recognize one touch, very similar to a click from a mouse. Now, touch screens are frequently capable of supporting multi-touch gestures which greatly increase the flexibility of touch screen devices. In the last decade there are many evolutions which took place in touch screen technology.

Major two are:-

- Touch walls are one example of the evolution of touch screens. These leading edge devices are currently seen only in high-end corporate environments, museums, and better education institutions.
- Another innovation in-tuned screen technology is optical recognition. This technology adds infrared to a white backlight to permit the camera to raise and visualize what's touching the touch surface. The image is then analyzed by a posh algorithm.

Below are major fields where touch screens take place in the upcoming future.

1. Retail Market: Retail's potential opportunities go beyond helping shoppers find products. Touch screen can be implemented in:

- Offer advice
- Answer questions
- Introduce new products

2. Innovation In Current Existing Touch Screens : Below are some modifications which can be done in the upcoming future in existing touch screens.

a. Minimal power requirement
b. Low cost and excellent durability
c. Zero pressure touch
d. High inherent accuracy and precision

3.3D Touch Screen: It is the most innovative idea which can take place in the touch screen world. As Samsung has already implemented 3d scanning cameras in smartphones so 3d screen would be best

to visualize the images like the real world. Apart from it users can get 3d screens in the digital entertainment world also.

VIII. CONCLUSION

In today's world,where screens have become an indispensable part of life, not many know about it. This research paper is a study of different technologies of touch screen. It took technological advancement and several generations to achieve this presence. But the story of touchscreen has not ended yet. There is a very wide scope of advancement for this technology.

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