Journal of Data Acquisition and Processing
ISSN: 1004-9037
https://sjcjycl.cn/
DOI: 10.5281/zenodo.7765814

A REVIEW OF SMART SCREEN TECHNOLOGY AND ITS TYPES

G. Siva Suresh Kumar[1], B.Janaki Ram[2], K.Lokesh[3], K.Bhavani Shankar[4], Y.Ramesh[5], Ch.Kalyan Kumar[6]
Asst. Professor[1], U.G.Students[2,3,4,5,6],
Department of ECE, N.S Raju Institute of Technology, Sontyam, Visakhapatnam, A.P, India

ABSTRACT:
The demand for display technology is being increased with the continuous invention of portable electronic devices and with the emergence of flexible, wearable, and transparent display devices. Touch screens have now become the part and parcel of our lives. We barely focus on the working of it while scrolling through Instagram or Facebook on our screens. we all have smartphones now in our hands, and we use them with ease and for entertainment. In today's generation, there is hard to find a person without an electronic gadget containing touch screens. This touchscreen have been used for a variety of different purposes since the first touch screen prototypes [2] saw the light of the day. Touch screens can at least be tracked back to the early 1970s. This touch screen critical component in display technologies that gear user interface operations. The next generations of touch screens are expected to sense multiple levels of pressure that 3-d touch screens do. To gear these 3-d touchscreens, transparent pressure sensors with high linearity over a working range that encompasses the pressure range of human touch i.e., 10 to 100kpa are required. In this work, the transparent and linear capacitive pressure sensor is reported with a transmittance of over 85% and high linearity over 5-100 kPa of pressure.[1] As years passed there are multiple types of touchscreen's invented that made exceptional changes with upgradation in the types of touchscreens.Some of them can be listed as

a) Resistance touchscreen
b) Capacitive touchscreen
c) Surface capacitive touchscreen
d) Project capacitive touchscreen
e) Surface Acoustic Wave (SAW)
f) Infrared touchscreen screen

INTRODUCTION:-

The scientists need to use some equipment that was so overworked that it was only available at night. you can imagine how much that inconvenience was slowing down their progress. It was then that a scientist named Dr.Hurst and his colleagues thought of using some electrically conductive paper in their research. By developing this idea, they eventually created the first computer touchscreen ever!

The touch interface is one of the most familiar user interface (UI) types in flattened-panel display devices such as mobile phones, tablet PCs, smartwatches, TVs, and so on. Traditional touch sensors enable a two-dimensional (2D) user experience by sensing the x-y coordinates

of the touch point on the touch panel. Many types of interfaces have been immensely studied by researchers to expand beyond the traditional 2D UX of display devices.[3]-[11]
In the commercial market on September 2015, Apple Inc. introduced a three-dimensional (3D) force-touch technology, which enables the display panel to recognize not only the x-y 2D coordinates but also the strength of the touch pressure force. The force-touch sensing provides additional control abilities to users, such as functions of picture zoom-in, text look-up, pop-up menu, etc. Fig. 1 shows the difference between 2D and 3D touch operations. Compared to 2D touch, a 3D touch panel requires an additional sensing layer for the z-axis and thus can detect the pressure force perpendicular to the panel.[12]
And at present The Touch screens gear the user to interact directly with what is displayed, rather than using a mouse, stylus, touchpad, etc.,
These touchscreens are now used in almost every field and devices in gaming, computer, tablet, mobile phones, point of sales systems, smartphones, etc., and these are also can be used to attach to computers or, as terminals, to networks.
These touch screens are usually layered on the top of the electronic visual display of an IPS, i.e., Information Processing System, and both as input-output devices. By Touching the screens with one or more fingers, a user can give input through simple or multi-touch gestures. The Touch Screen allows us to interact with the display interface, rather than using an external device such as a mouse, touchpad, or any other device type of touch screen and its workings.
What's the magic behind the touchscreens we know and love today? If you thought that just one technology stands behind this "swipable" phenomenon of our time, think again! There are more than half a dozen approaches to making touchscreens work. The technology is simple: you press on the screen hard enough, and it bends and resists your touch.
So let us know more about the history and classifications of the Touch Screens.

HISTORY:-

- The touchscreens already appeared way back in the '60s!...
- The first touchscreen developed was the Capacitive Touch Screen. 1965 E.A. Johnson invented, what is generally considered the first finger-driven Touch Screen. In 1965 touch screen was developed in Malvern, England.
- In the early 1970s Engineers from CERN (European Organisation For Nuclear Research) developed a transparent touchscreen.
- The two Engineers Frank Beck and Bent Stumpe developed this transparent Touch screen.
- After this George Samuel Hurst, an American inventor developed the first Resistive Touch screen and received US Patent No.3,911,215 on October 7, 1975.[13]
- The Touch Screen Began to become commercialized during the 1980s when Hewlett - Packard created the HP150. This computer featured a 9'CRT Display, with Infrared(IR)detectors around the edge that could detect when a user's finger interacted with the screen.
- The mass adoption of projected capacitive (or P-CAP) touch technology by smartphones and tablets, has created a greater demand for large format, commercial applications such as; digital signage, industrial, and point of sale (POS), to become interactive, and here's where the technology has come into its own.

Processing System, and both as input-output devices. Touch screens are usually employed in laptops, tablets, or smartphones.

By touching the screens with one or more fingers, a user can give input or control the information processing system through simple or multi-touch gestures. The touch screen allows the user to interact with the displayed interface, rather than using an external device such as a mouse, touchpad, or any other device Types of touch screens and their workings.

Classifications:

There are different sorts of touch screens, and they have different working principles and structures according to their uses and the material used.

RESISTIVE TOUCH SCREEN:

These are the most integral and commonly used touch screens, usually found at ATMs and supermarkets, that often need an electronic signature with a small grey pen. . These screens will "resist" your touch; if you press hard enough, you would feel the screen compressing slightly. These are the reasons which make screens resistive - two electrically conductive layers bending to touch one another, as in this picture: One of those thin yellow layers is consistent, and the other is conductive, distanced by a gap of tiny dots called spacers to keep the two layers at a distance until you touch it.[14,15]

(A thin, blue layer that is scratch-resistant rests on top and completes the package). An electricalcurrentflows mainly through the yellow layers, but when your fingers touch the screen, both of them are pressed together, and the electrical current changes right at the point of contact. The software identifies a change in the current, at these points and carries out the function that communicates with that spot. Resistive touch screens are robust and efficient,Resistive touch screens are robust and efficient, but they're challenging to read as the multiple layers reflect more context light.

They can also only deal with one touch at a time, not possible for multi-touch such as the two-finger zoom on an iPhone.

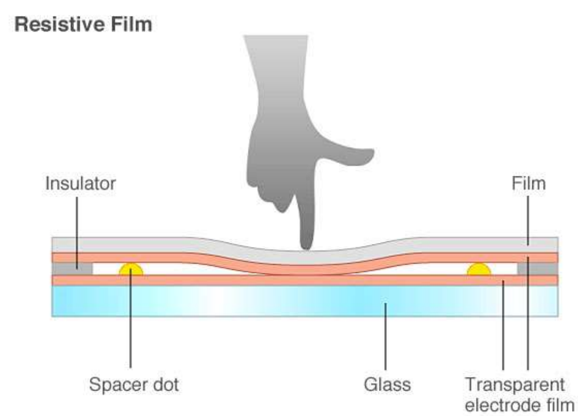

Image Reference: https://www.mikroe.com/blog/capacitive-vs-resistive-touch-panel-feels-better

This is the reason why high-end devices prefer to use capacitive touch screens that detect anything that conducts electricity.

CAPACITIVE TOUCH SCREEN:

Opposite to resistive touch screens, to make a change in the flow of electricity, capacitive screens do not use your finger'spressure. Instead, they deal with anything which contains an electrical charge - including human skin.

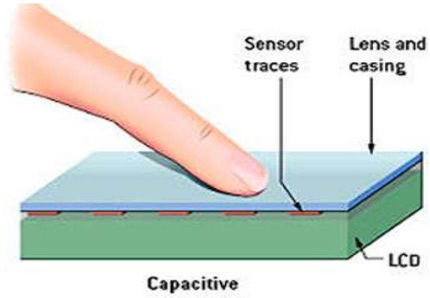

Image Reference: https://shophkb.off63.cf/products.aspx?cn

(Yes, they are composed of atoms with both + and - charges) Capacitive touch screens are produced from copper or indium tin oxide materials that help save electrical charges. These charges are saved in an electrostatic grid of tiny wires, with each being thinner than a human hair.

Ever Wondered why our mobiles won't respond when you're wearing gloves? The problem is that clothes don't conduct electricity(unless you have special gloves fitted with conductive threads of course.)

The capacitive scheme is divided into surface-capacitive [17,18] and projected-capacitive methods [19,20].

<u>SURFACECAPACITIVE TOUCH SCREEN:</u>

Surface capacitive screens use sensors around the edges and a thin, finely divided film around the surface.Surface-capacitive touchscreens consist of one conductive layer of which four corners are connected to four perfectly synchronized alternative current (AC) voltage signals. In contrast, projective capacitive screens use a grid of columns and rows with a distinct chip for sensing.

In both cases, when a finger touches the screen, a little electrical charge is passed to the finger

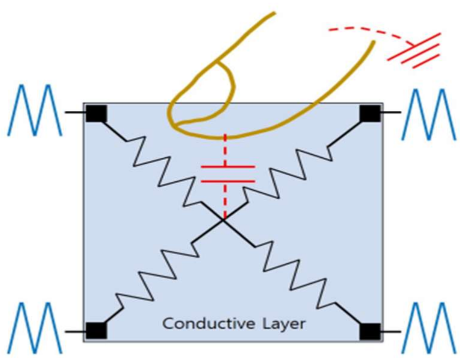

Figure 3. Surface-capacitive touchscreen. The touch location can be estimated from the current variation at four corner AC voltage sources caused by the finger touch.

Image Reference: reference no. 16

to complete the circuit, creating a voltage drop on that point of the screen. (This is why capacitive screens would not respond if you are wearing gloves; clothes do not conduct electricity unless they have attached conductive threads.),The software deals with the location of this voltage drop and orders the evolving action.[16]

PROJECT CAPACITIVE TOUCHSCREEN

The process of a Projected Capacitive Touch screen much resembles regular capacitive touch screens. The projected-capacitive methods can be further divided into self-capacitance and mutual capacitance architectures. Especially, the mutual capacitance has been the mainstream technology used in most consumer electronics such as smartphones, tablet PCs, and notebook PCs since the appearance of iPhones in 2007, because it can support multi-touch functions along with high durability and good optical clarity.The fingertouch increasestheselfcapacitance due to the additional parasitic capacitor in parallel and decreases the mutual capacitance due to the electric field loss by the finger placed between two electrodes.[16]

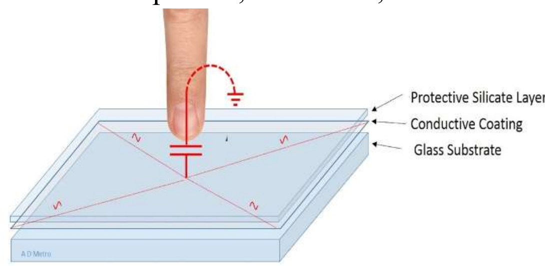

Image Reference: reference no. 16

Still, they have possessed two significant benefits over normal capacitive touch screens:They are receptive to surgical gloves or thin cotton gloves, and they create multi-touch features possible. Multi-touch relates to when two fingers at the same time activate the touch screen. A PCT (projected capacitive touch screen) is comprised of a glass sheet with embedded transparent electrode films. These, along with an IC chip, will develop a 3D electrostatic field.

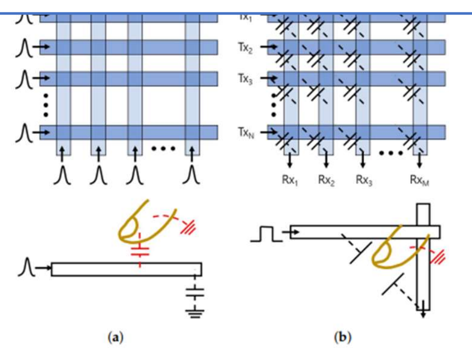

Figure 4. Projected-capacitive methods. **(a)** Self-capacitance. **(b)** Mutual capacitance.

A difference in the electrical currents is noted when a finger touches the screen. A touchpoint is then to be noted.

Image Reference: reference no. 16

Do you know why our screens do not respond to our touch in water?

It is because water also conducts electricity.so your screen can recognize where your finger is!!.

Projected capacitive touch screens are being used more and more in different industries and are generally taken over regular capacitive touch screens because of their period.

A difference in the electrical currents is noted when a finger touches the screen.

A touchpoint is then to be noted.

Projected capacitive touch screens are being used more and more in different industries and are generally taken over regular capacitive touch screens because of their period

SURFACE ACOUSTIC WAVE (SAW)):-

A Surface Acoustic Wave (SAW) touch screen works a little less than resistive and capacitive touch screens. (. (SAW) touch screens use transducers mounted on the corner of a glass panel. The transducers create a concealed grid of ultrasonic waves on the surface received by sensors, hence the name surface acoustic wave. When a person touches the screen, some of this wave is captivated. The receivers find out the touchpoint and send this information to the computer.

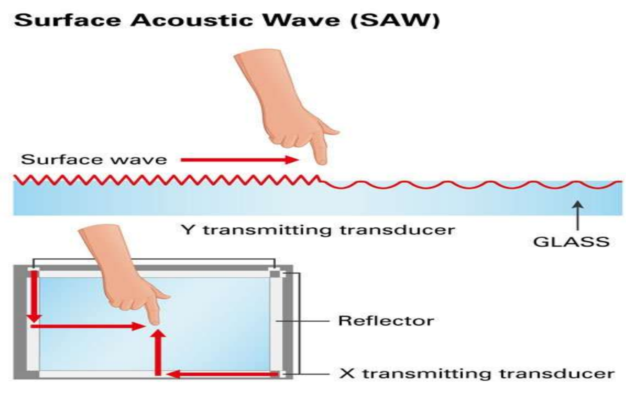

Image Reference: reference no. 16

(SAW) touch screens can be run using a finger, a gloved hand, or even a stylus. They are straightforward while using and feature extensive visibility; besides, boasting increased optical clarity and prolonged touch life. They have some disadvantages, such as that they cannot be activated with hard objects, e.g., pens, credit cards, or fingernails. Wrong-way touches are also a risk, especially by water droplets, while solid contaminants on the screen can create non-touch areas until the dust or dirt is cleaned out.[21-23,24]

<u>INFRARED TOUCH SCREEN</u>:-

Other than other technologies, infrared touch screens do not overlay the screen with an extra layer. These types of touch screens are built on light beam interruption technology. An infrared touch screen makes use of infrared emitters and receivers while creating a transparent grid of infrared light beams all across the screen.

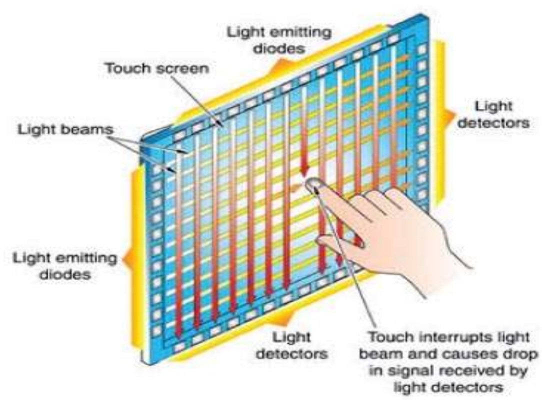

Image Reference: reference no. 16

The absence of an extra film or layer indicates the best image quality and clarity.

When an object interrupts the light beams, a sensor detects the touch of the user. [14]

This helps multi-touch and also does not require the user to apply pressure to register a touch. Even if the screen is scratched, it works fine, and other objects aside from one's fingers can be used to work with this touch screen.[15]

The warning to this technology is that sunlight can sometimes affect its functionality.

<u>PRESENT INVENTIONS:</u>

The Researchers at the Indian Institute Of Technology(IIT) Madras have claimed to develop a technology through which users can touch the images on a screen and feel them by getting a sensation of their texture. The IIT-M scientists have devised a touchscreen display technology enabling a person to feel the textures from photos as the finger moves across the touch surface.

<u>How Does iTad Work?</u>

According to the institute, the invention called 'iTad' is an interactive touch active display and is the next generation in Touch Display technology. The researchers can create different textures, such as switches, crisp edges, and rich textures ranging from smooth to gritty with the use of this software. A unique level of interaction comes alive on smooth physical surfaces.

There are no moving parts in iTad; instead, an in-built multi-touch sensor detects the finger's movement, and surface friction is adjusted via software. The institute claimed that the software adjusts friction locally when fingers move across a smooth plane by regulating electric fields via a phenomenon known as "electroadhesion,".

A Deep Dive Into The New Invention!

The invention was led by Professor M Manivannan, CoE on Virtual Reality and Haptics, Department of Applied Mechanics, IIT-M. Merkel Haptics, a start-up brooded at the IIT-M Research Park, has been working with the Touchlab researchers to carry the technology forward.

Highlighting the impact this technology could have on Electronic Appliances, Prof M Manivannan stated, "This is the era of iTad. The technology can take the online shopping experience to the next level. We can touch and feel things before we buy from e-commerce platforms. Around 30 per cent of returns to online shopping are due to the mismatch of user experience, their expectation is different by looking at the images online."

Further, elaborating on the current status of 'iTad' and a timeline for hitting the market with possible applications in the real world, Dr PV Padmapriya, CEO of Merkel Haptics, said, "The prototype from the Touchlab can be made into the product in a year's time. Our aim is to make a small device, similar to a computer mouse, on everyone's desk to add to the experience. We have been field testing and providing valuable feedback to the researchers at IIT Madras on improving the functionality of the technology."[25]

Conclusion:

This Review paper tries to explain that, Nowadays everyone is familiar with touchscreens and they got habituated to them,but many don’t know what is the technology behind themi.e, how these touch screens work, what are the types, How these Types are distinguished,how the sense the touch,etc., so this paper just give you review on Touch Screen and Touch Screen technology.

REFERENCES:

1. Transparent Pressure Sensor with High Linearity over a Wide Pressure Range for 3D Touch Screen Applications: Han Byul Choi, Jinwon Oh, Youngsoo Kim, Mikhail Pyatykh, Jun Chang Yang, Seunghwa Ryu, and Steve Park.
2. Uses Bent Stumpe’s work as reference: Bhalla, M.R. and Bhalla , A.V.(2010): comparative study of various Touchscreen Technologies.
3. J. C. Lee, P. H. Dietz, D. Leigh, W. S. Yerazunis, and S. E. Hudson, “Haptic pen: A tactile feedback stylus for touch screens,” in Proc. 17th Annu. ACM Symp. User Interface Softw. Technol., 2004, pp. 291–294.
4. I. Rosenberg and K. Perlin, “The UnMousePad: An interpolating multitouch force-sensing input pad,” ACM Trans. Graph., vol. 28, no. 3, Aug. 2009, Art. no. 65.

5. C. Rendl, P. Greindl, K. Probst, M. Behrens, and M. Haller, "Presstures: Exploring pressure-sensitive multi-touch gestures on trackpads," in Proc. SIGCHI Conf. Human Factors Comput. Syst., 2014, pp. 431–434.
6. L. Du et al., "A single layer 3-D touch sensing system for mobile devices application," IEEE Trans. Comput.-Aided Design Integr. Circuits Syst., vol. 37, no. 2, pp. 286–296, Feb. 2018.
7. W. Kim, H. Oh, Y. Kwak, K. Park, B.-K. Ju, and K. Kim, "Development of a carbon nanotube-based touchscreen capable of multi-touch and multi-force sensing," Sensors, vol. 15, no. 11, pp. 28732–28741, Nov. 2015.
8. H.-S. Yeo, J. Lee, A. Bianchi, and A. Quigley, "WatchMI: Pressure touch, twist and pan gesture input on unmodified smartwatches," in Proc. 18th Int. Conf. Hum.-Comput. Interaction Mobile Devices Services, 2016, pp. 394–399.
9. S. Heo and G. Lee, "Force gestures: Augmenting touch screen gestures with normal and tangential forces," in Proc. 24th Annu. ACM Symp. User Interface Softw. Technol., 2011, pp. 621–626.
10. C. Rendl, P. Greindl, M. Haller, M. Zirkl, B. Stadlober, and P. Hartmann, "PyzoFlex: Printed piezoelectric pressure sensing foil," in Proc. 25th Annu. ACM Symp. User Interface Softw. Technol., 2012, pp. 509–518.
11. C. Park, S. Park, K.-D. Kim, S. Park, J. Park, and B. Kang, "A penpressure-sensitive capacitive touch system using electrically coupled resonance pen," IEEE J. Solid-State Circuits, vol. 51, no. 1, pp. 168–176, Jan. 2016.
12. Thermal-Variation Insensitive Force-Touch Sensing System Using Transparent Piezoelectric Thin-Film : Min-Woo Kim , Dong-Kyu Kim, Tetsuhiro Kodani, Takashi Kanemura, Hui-Dong Gwon , Gyu-Hyeong Cho, Fellow, IEEE, Kwan-Young Han, and Hyun-Sik Kim , Member, IEEE.
13. A Review Paper on Touch Screen Harshit Sharma.
14. https://www.google.co.in/search?q=Development+touch+screen+diagram&dcr=0&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjh56zd557WAhVBJVAKHcFgDUEQ_AUICig B&biw=1242&bih=557 .
15. https://en.wikipedia.org/wiki/Touchscreen#Technologies.
16. Review of Capacitive Touchscreen Technologies: Overview, Research Trends, and Machine Learning Approaches :Hyoungsik Nam * , Ki-Hyuk Seol, Junhee Lee, Hyeonseong Cho and Sang Won Jung.
17. Krein, P.T.; Meadows, R.D. The electroquasistatics of the capacitive touch panel. IEEE Trans. Ind. Appl. 1990, 26, 529–534. [CrossRef].
18. Yanase, J.; Takatori, K.; Asada, H. Algorithm for Recognizing Pinch Gestures on Surface-Capacitive Touch Screens. Dig. Tech. Pap. Int. Symp. SID 2015, 46, 899–902. [CrossRef].
19. Barrett, G.; Omote, R. Projected-Capacitive Touch Technology. Inf. Disp. 2010, 26, 16–21. [CrossRef].
20. Walker, G. Part 1: Fundamentals of Projected-Capacitive Touch Technology. Available online: http://www.walkermobile.com/Touch_Technologies_Tutorial_Latest_Version.pdf (accessed on 23 April 2021).

21. Dieulesaint, E.; Royer, D.; Legras, O.; Chaabi, A. Acoustic plate mode touch screen. Electron. Lett. 1991, 27, 49–51. [CrossRef].
22. Nara, T.; Takasaki, M.; Maeda, T.; Higuchi, T.; Ando, S.; Tachi, S. Surface acoustic wave tactile display. IEEE Comput. Graph. Appl. 2001, 21, 56–63. [CrossRef] 87.
23. Takasaki, M.; Kotani, H.; Mizuno, T.; Nara, T. Transparent surface acoustic wave tactile display. In Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems, Edmonton, AB, Canada, 2–6 August 2005; pp. 3354–3359.
24. Hao, X.; Huang, K. A Low-Power Ultra-Light Small and Medium Size Acoustic Wave Touch Screen. Appl. Mech. Mater. 2014, 513–517, 4072–4075. [CrossRef].
25. https://thelogicalindian.com/trending/iit-madras-develops-touchscreen-technology-i-tad-that-enables-users-to-feel-texture-of-images-38116.