Projected Capacitive (PCAP) Touch Screens in Defense and Aerospace

Read About

Projective capacitive (PCAP) touch technology
Resistive capacitive touch technology
Surface capacitive touch technology
Surface acoustic wave touch technology
Infrared touch technology
Rugged touch screens

Modern Touch Screens for the Modern Warfighter

There is no question that touch screens are a useful asset for warfighters in the field. With a touch-based user interface, they can make selections, enter information, and interact with systems with no need for a space-consuming mouse or keyboard. Furthermore, training times are typically lower than with traditional user interfaces. And, with no peripheral components to juggle and manipulate in tight spaces, warfighters are free to concentrate on the task at hand.

While touch screens are ideal for field applications, finding touch screen technologies that can handle the demands of harsh environmental conditions encountered in aerospace and defense applications is challenging. There are a number of touch screen technologies to choose from, but each one has limitations:

Table 1

	RESISTIVE	SURFACE CAPACITIVE	PROJECTED CAPACITIVE	SURFACE ACOUSTIC WAVE	INFRARED
Visibilty in sunlight	Average	Good	Good	Good	Very good
Resolution	High	Average	High	Average	High
Touch sensitivity	Pressure required, responds to gloved/wet hands and stylus	Responds to bare hands, capacitive stylus, or special capacitive gloves	No pressure required, responsive and accurate, latest technology works with gloved/wet hands and stylus	Responds to fingers or soft tipped stylus without pressure	Responds to any pointing device, without pressure
Cost	Affordable	Affordable	Most affordable	Expensive	Very expensive
Multi-touch	Cumbersome and difficult	No	Yes	No	Yes
Durability	Vulnerable to scratches, unaffected by surface contaminants	Resistant to casual scratches, moisture and other surface contaminants	Resistant to casual scratches, moisture and other surface contaminants	Susceptible to dirt, moisture, and false touches	Susceptible to dirt, moisture, and false touches

Table 1: Touch screen technology comparison

- Resistive touch screens require users to apply physical pressure to the screen and can be used while wearing gloves, but dragging and sliding motions are often cumbersome and difficult to successfully execute.
- Surface capacitive touch screens consist of an insulator, such as glass, coated with a transparent conductor, such as indium tin oxide (ITO). As the human body is also an electrical conductor, touching the surface of the screen results in a distortion of the screen's electrostatic field, measurable as a change in capacitance[1]. This means they can be used with bare hands, a capacitive stylus, or while wearing special gloves made with capacitive fibers.
- Projected capacitive (PCAP) touch screens operate in a similar way to surface capacitive touch screens, but also support intuitive, multi-touch gestures. To date, commercial PCAP touch screens have been known to generate electromagnetic interference (EMI) and radio frequency interference (RFI) unsuitable for military environments.
- Surface acoustic wave touch screens detect changes to the ultrasonic waves that are just below the screen to determine touch points. They can be used while wearing gloves, but are quite sensitive to water droplets or touch from other "soft" objects.
- Infrared touch screens detect touch when an object breaks the grid of infrared light beams that are located just above the screen. While infrared touch screens offer excellent visual clarity, they are very sensitive to dirt, oily buildup, or water droplets on the screen. It is also easy to make unintentional touch gestures.

To date, the industry has primarily relied on ruggedized resistive touch screens because they can be used while wearing gloves and don't create interference issues. However, as the profile of warfighters changes, expectations for field technologies are also changing. Today's modern warfighters grew up in the age of smartphones and tablets with intuitive, multi-touch PCAP touch screens. They rely heavily on these devices in their personal lives, and they expect to have access to the same capabilities and conveniences in the field.

The good news is that now is the right time for defense and aerospace organizations to evolve to PCAP touch screens. While PCAP touch screens have had interference issues that meant they couldn't be used in rugged field applications, those issues have been overcome. A combination of advancements in technology and innovations by leading industry display technology vendors mean PCAP touch screens are now the ideal choice for almost any program, platform, or application.

Before taking a closer look at the technical challenges that have been overcome in PCAP touch screens, it is important to understand the benefits they provide over resistive touch screens.

PCAP vs. Resistive Touch

The differences between resistive and PCAP touch screens start with the materials that are used and the way the technologies are implemented.

In a resistive touch screen, two layers of electrodes separated by an air gap sit just behind the screen. Tiny plastic microbeads are used to maintain the air gap between the electrode layers. To register a touch, users must apply enough pressure to the screen to squeeze the microbeads together so the two layers of electrodes touch. This creates a voltage change that signifies the touch action.

A PCAP touch screen is composed of solidly bonded optical screen layers so, unlike resistive screens, there is no air gap or microbeads that must be depressed. Instead, the screen detects, and reacts to, the static electrical charge of the object that touches it.

These basic differences in materials and design give PCAP touch screens a number of key advantages over resistive touch screens that help warfighters improve the way they work and contribute to mission success.

[1] https://en.wikipedia.org/wiki/Touchscreen

Clarity, Contrast, and Readability

The air gap between the layers in a resistive touch screen reduces image clarity, making it harder to read than a PCAP display. Natural and artificial light bounce off the air gap creating reflections that reduce contrast and readability. In addition, the plastic microbeads that separate the screen layers add a granular effect to images, further reducing image clarity and crispness. While brightness settings can be used to compensate for contrast issues, there's nothing that can be done to compensate for the granular effect that degrades image quality.

Because they don't include an air gap between screen layers or plastic microbeads, PCAP touch screens don't suffer from the reflection and image clarity issues that resistive touch screens experience. They provide a crisper, higher quality image and higher contrast levels that make it easier for the user to see and absorb screen content at a glance.

Usability, Versatility, and Speed

The need to apply physical pressure to a resistive touch screen often makes it slow and difficult to perform actions. While single-touch selections are typically easy enough to execute, actions such as entering information, scrolling, and dragging objects across the screen can be painstaking and error-prone. When trying to respond quickly to a situation, under stress, or trying to concentrate on the task at hand, it's very easy to apply an inconsistent or insufficient level of pressure when interacting with a resistive touch screen. This can cause the touch action to partially or completely fail.

With PCAP touch screens, the user doesn't need to worry about consistently applying the right level of pressure to the screen. Instead, they can simply slide their fingers across the screen using the same intuitive, multi-touch gestures they are already familiar with to drag screen objects, zoom in and out of images, and swipe in all directions. When warfighters can quickly and easily interact with the touch screen using motions that are second nature to them, they can focus fully on the task at hand.

Weight, Durability, and Lifespan

In addition to being harder to read and more difficult to use, resistive touch screens also tend to be heavier than their PCAP counterparts. This is a key disadvantage on defense and aerospace platforms where keeping weight at a minimum is crucial. The non-bonded screen layers and plastic microbeads in resistive touch screens also mean there are more parts that can degrade, reducing their overall lifespan.

Because users must physically press the resistive touch screen each time they interact with it, resistive touch screens can wear down and become unresponsive over time, especially in heavy use situations. In addition, as resistive touch screens bend when touched, the front-end glass surface has to be very thin (fraction of a millimeter) which makes it prone to damage and breakages; whereas a PCAP touch screen is fitted behind a thicker (typically three millimeter) glass. If a resistive touch screen is cracked or damaged, it typically stops functioning. These issues are far less likely to occur in PCAP touch screens, which are extremely scratch resistant, and often continue to function even if the screen does crack. We've all seen people successfully using PCAP smartphones and tablets with cracked, and even shattered, screens.

The inherent ruggedness and reliability of PCAP touch screens means they have a longer lifespan in the field, even when subjected to physical and environmental stresses.

Overcoming PCAP Challenges

When PCAP touch screens were introduced in commercial devices a number of years ago, their high levels of readability, usability, and durability soon made them the de facto standard in smartphones, tablets, and other personal computing devices. Unfortunately, despite their many advantages, a number of critical limitations meant that PCAP touch screens could not be used for defense and aerospace applications.

However, since PCAP screens were first introduced, the technology has rapidly evolved. At the same time, leading industry display vendors have put significant time, effort, and resources into addressing the limitations of PCAP screens so that warfighters can benefit from them in the field.

Developing a PCAP touch screen that can be effectively used in rugged applications requires deep knowledge about a wide variety of hardware and software technologies and how they must come together to eliminate the issues that have historically prevented their use in the field.

Using a PCAP Screen with Gloves

In the past, both surface capacitive and PCAP touch screens required users to interact with the touch screen with their bare hands. This requirement has obvious limitations for warfighters who are often exposed to extremely harsh environmental conditions and potentially dangerous equipment where gloves are mandatory for personal protection. While capacitive gloves are available, they are not known for their warmth or protective properties.

Today, computer processors are much faster than they were when PCAP touch screens were initially developed, software algorithms are smarter, and electronics are much better at interpreting touch actions. As a result, users can now successfully interact with PCAP touch screens, even while wearing heavy winter or safety gloves.

Dealing with Water Drops

The same advances in computer processing, algorithms, and electronic intelligence that allow users to wear gloves also enable PCAP touch screens to distinguish between a touch action and a drop of water falling on the screen. In the past, PCAP screens stopped working if water drops fell on the screen because the electronics couldn't determine what it meant.

Now, PCAP touch screens are smart enough to ignore a few drops of water on the screen. While the parts of the screen with the water drops cannot be used, the rest of the screen functions normally.

Resolving EMI and RFI Issues

EMI and RFI issues were some of the biggest reasons PCAP touch screens could not be used in defense and aerospace applications. Because PCAP touch screens include electronically driven liquid crystal displays (LCDs) as well as processors, backlighting, and power supplies, they generate electrical noise. With the amount of sensitive electronic and radio equipment on defense and aerospace platforms, the resulting interference made PCAP touch screens virtually unusable.

This is where leading vendors of ruggedized touch screens for military applications have adapted the internal electrical connections and enclosures used in PCAP touch screens to dramatically minimize the electrical noise they emit. Today, with the advanced signal filtering and specialized grounding these vendors have implemented, it is possible to find PCAP touch screens that comply with:

+ MIL-STD-461F for radiated emissions and electromagnetic compatibility
+ MIL-STE-1275E for electrostatic discharge

Ruggedization

As experts in ruggedization, military solution vendors have also led the way in ensuring that PCAP touch screens can withstand the physical and environmental challenges of field deployments.

With their efforts, PCAP touch screens can now be confidently deployed on platforms that are exposed to extreme temperatures, high vibration levels, and severe weather conditions. They are engineered and manufactured from the ground up to ensure reliable performance in the field for many years. With these advancements, system integrators can now source PCAP touch screens that:

+ comply with MIL-STD-810G for environmental engineering design and testing
+ provide an IP65 level of ingress protection from dirt, moisture, and other contaminants

Rugged, Reliable PCAP Screens

To create a higher level of dependability, developers and system integrators must focus on simplifying the relationship between warfighter and machine. Solutions must be smaller, stronger, smarter, and faster.

Curtiss-Wright's Ground Vehicle Display Unit (GVDU) PCAP touch screens meet these criteria. They provide market-leading performance and are engineered for ground vehicle requirements according to the Generic Vehicle Architecture (GVA) standard. These bright, crisp, and high-contrast displays deliver the functionality warfighters expect with the size, weight, power, and cost (SWaP-C) system integrators require. The GVDU:

+ provides a rich and flexible feature set that is ideal for intelligence, surveillance, and reconnaissance (ISR), situational awareness, mapping, and navigation applications in a SWaP-optimized, fully sealed enclosure
+ includes bezel buttons that are based on the GVA standard
+ is ruggedized and qualified to established military standards, including MIL-STD-810G, MIL-STD-461F, and MIL-STE-1275E
+ includes MIL-C-38999 connectors for power, video, and other interfaces
+ supports a wide variety of interfaces and video over Ethernet
+ features powerful LED backlights and optical bonding to reduce internal reflection and enhance contrast

The GVDU touch screen developed by Curtiss-Wright fully aligns with the company's philosophy of providing simple, low-SWaP displays that increase flexibility and reliability, simplify maintenance and upgrades, extend lifespan, and reduce costs. They complement the Advanced Video Display Unit (AVDU), Single Video Display Unit (SVDU), and Rear View Display Unit (RVDU) product lines, giving system integrators a complete family of ruggedized and cost-effective mission displays that simplify interoperability between legacy and new video equipment to reduce time-to-market and risks. For maximum flexibility, Curtiss-Wright's mission displays are available as standalone units, or as part of a fully integrated video management system (VMS) that includes ruggedized mission computers, video distribution systems, and video recorders.

Together, these video solutions demonstrate Curtiss-Wright's commitment to helping warfighters leverage advanced, highly reliable video technologies to increase mission success. And they are another example of why Curtiss-Wright has been a trusted, proven leader in defense and aerospace for decades.

For more information about how advanced video technologies can be leveraged for a tactical advantage in the field, see our white paper Why Smart Video Displays May not be the Smartest Choice.

Figure 1: PCAP Ground Vehicle Display (GVDU)

Author(s)

Richard Brown
Hardware Engineer
Curtiss-Wright Defense Solutions

Val Chrysostomou
Sr Product Manager
Curtiss-Wright Defense Solutions

Learn More

White Papers

- Ground Vehicle Video Management System Integration
- The Challenges of Cost Effective Video Management System Integration
- High Definition Video Management System for Airborne Applications
- Reducing Complex Integration Efforts with SWaP-C Optimized Video Switching

Case Studies

- Helicopter Integrator Eliminates Video Latency Increasing Mission Effectiveness
- Integrated Video Management and Digital Mapping Systems Increase Mission Effectiveness
- Video Distribution System for SAR Helicopter
- Fully Integrated Ground Vehicle Computing and Video Solution