Adding a new dimension to capacitive touch sensing

Whitepaper

UltraTouch Works Anywhere

In the Rain

Underwater

Under Metal or Plastic

With Gloves

Unleashing a wave of new touch control applications and flexible form factors from underwater smartphones to automotive, industrial and medical touch surfaces capable of gloved hand and harsh environment operation

camtouch3d.com/benefits-of-ultratouch

Cambridge Touch Technologies

The use of capacitive touch sensing has become ubiquitous for all manner of products. From our smartphones, bank ATMs, the train ticket self-service kiosk, and for a myriad of other applications, projected capacitive touch sensing has become the defacto must-have user interface. It has achieved that status in little more than fifteen years thanks to the features it has made possible. **Still, limitations linger...**

Compared to the previous generation of bulky resistive touch screens, where the sensing elements were in front of the display cover, capacitive touch sensing techniques allowed the fine sensor wires - the stack-up - to be behind the glass cover. Smartphone manufacturers latched on to this approach immediately, since it allowed them to make their phones sleek in appearance and keep all the sensitive electronics sealed behind a single glass sheet at the front of the phone. This clean, wipeable, and elegant approach helped the smartphone become the most fashionable piece of consumer technology of the 20th century. Overnight projected capacitive (PCAP) touch screens enabled a revolution in user interface design, introducing the concept of gestures, and allowing manufacturers to drop the use of a conventional keypad and associated buttons. As capacitive touch stack-ups evolved, they became thinner and more sophisticated as the concept of apps gained traction, further increasing adoption and consumer preference. Single-touch wheels, sliders, and buttons - traditional entry points for dust, moisture and other unwanted foreign objects - gave way to multi-touch. Today, the buttons on consumer devices are usually restricted to on/off and volume control only, while capacitive touch screens and associated displays are commonplace on everything from wrist fitness trackers, automotive infotainment systems, to high-resolution laptops.

*Capacitive touch screen technology is leaping forward with a new kind of touch sensing called **UltraTouch***

As consumers, our experience with capacitive touch sensing probably manifests itself the most through our smartphone. Over time, we have all encountered times when the touch sensor operation becomes erratic or freezes completely. More often than not, that is due to moisture on the phone's cover glass. You might have tried to use your phone with damp fingers, or you might be outside in a rain shower, or it might be due to condensation caused by moving into a warm room from the outside during winter. Think about your smartwatch, where you have to wipe the screen dry with your raincoat sleeve before using it. Whatever the scenario, your device becomes unusable until you dry the screen. The fact that the device doesn't work well in such situations limits the number of use cases, but moisture isn't the only challenge. Wearing a glove, an everyday occurrence in the winter months or in industrial and medical environments, also causes problems for a touch screen. As designers come up with even more consumer technology, the environmental conditions it may encounter might limit adoption. Likewise, manufacturers of industrial automation and control systems, keen to differentiate their product through the use of intuitive user interfaces enabled by touch screen technologies, may also meet challenges to growth due to the limitations of current capacitive touch sensing technologies.

Consider a GPS designed for outdoor use such as hiking or kayaking. The screen is essential for a map, chart, and route information display, but the product has to rely on buttons to control the user interface reliably. The buttons create design constraints to prevent the ingress of moisture and dust, increasing the bill of materials costs, and leaving a product looking somewhat dated. Imagine if you could take a picture with your smartphone underwater. Consider how product development could evolve so that new products could incorporate a touch screen for use underwater. How about a dive computer with a touch screen that would operate underwater with a gloved hand?

Capacitive touch screen technology is leaping forward with a new kind of touch sensing called UltraTouch.

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Introducing UltraTouch

UltraTouch, developed by Cambridge Touch Technologies, Ltd (Cambridge, UK), combines traditional capacitive touch sensing techniques with a force touch sensor. This augmented approach takes inputs from both sensors and passes them though signal processing algorithms. The processing yields an output signal that presents a 3D multi-touch representation of what is happening on the screen surface.

Figure 1 illustrates the construction of an UltraTouch stack-up. Sense and drive electrodes form the capacitive touch sensor, and a single layer of a piezoelectric film comprises the force sensor. The piezo layer permits simultaneous measurement of location and force from a mechanically robust and highly scalable sensor. Advanced signal processing of both sensor outputs yields significant improvements in signal-to-noise ratio and the ability to detect sensor performance integrity. Should the capacitive touch signal quality degrade or lock-out, indicating the presence of moisture, the force sensor output can become the dominant output. Combining advanced software techniques with the next generation of display stack-up, UltraTouch delivers all the benefits of traditional capacitive touch sensing as well as multi-force detection, the ability to operate underwater or with a gloved hand or a stylus, and haptic-compatible operation. UltraTouch is scalable to any size of screen or touch area, is particularly suited to flexible OLED, and is drop-in compatible with over 200+ capacitive touch panel module suppliers worldwide.

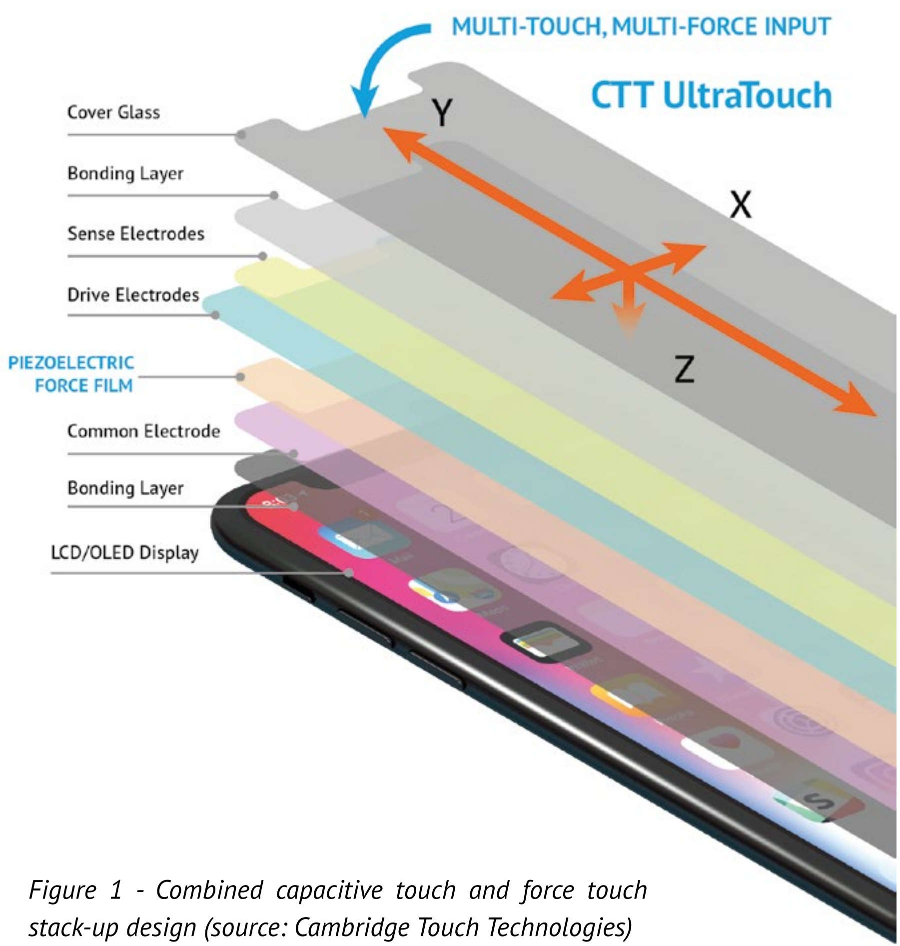

Figure 1 - Combined capacitive touch and force touch stack-up design (source: Cambridge Touch Technologies)

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The piezoelectric film used is optically transparent and, with same or better optical properties as PET or COP film, does not impact display clarity. Furthermore, there are myriad non-optical applications such as 'buttonless' surfaces where the piezoelectric film can be used as well to enable robustness and modern aesthetic design, for example for car seat control or the front control panel of a next-generation washing machine where touch-under-metal is desired. Also, the piezoelectric film, being a passive layer that self-generates a signal response and therefore does not require power for operation, makes it a low power candidate to, for example, wake up a smartphone from sleep instead of having to keep a fingerprint sensor constantly active and consuming valuable battery life.

The UltraTouch approach is agnostic of the type of capacitive touch controller IC used in a specific product design, affording a convenient method of updating an existing product as well as developing a new leading-edge product. This is achieved by incorporation of either a commercial-off-the-shelf microcontroller or the proprietary and low-cost UltraTouch IC that is 'bridged' to the touch IC, depending on the application under consideration.

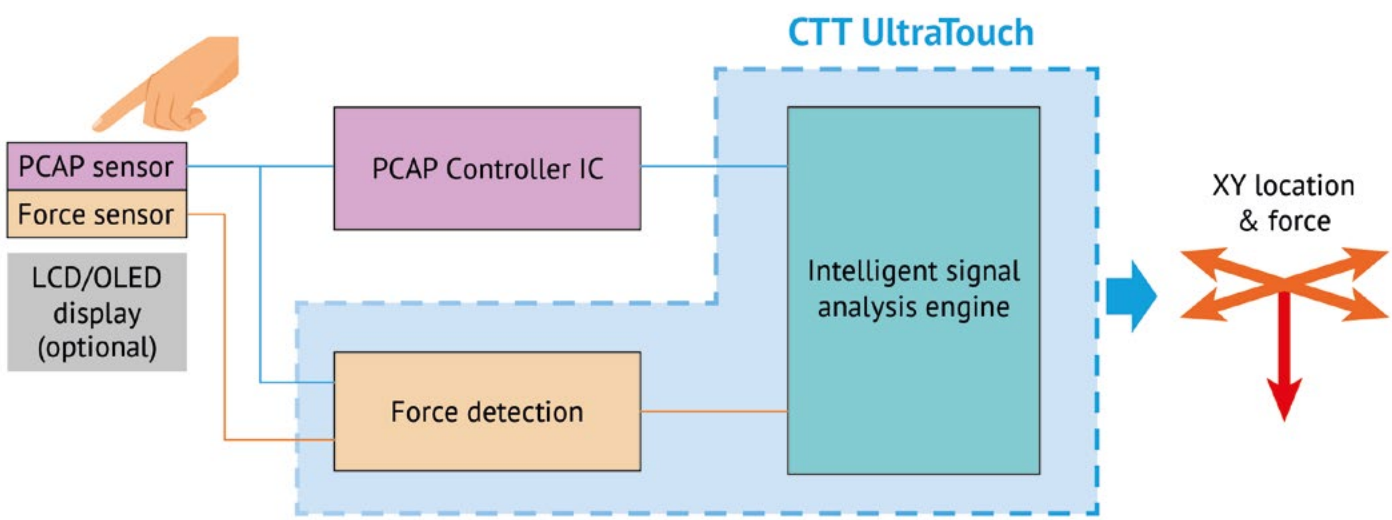

Figure 2 - The architecture of an UltraTouch solution (source: Cambridge Touch Technologies)

Figure 2 highlights how the multi-touch force and capacitive touch sensor data are combined. Digital signal processing algorithms work on the signals from the touch controller IC and the output from the force sensing analog front end. They remove unwanted DC offsets, and various filters decouple redundant data, while noise estimation techniques set the noise floor for the force-based signals. Deconvolution algorithms process the combined data to determine the touch location and the magnitude of the applied force. If necessary, scaling factors increase the force signal output to suit the user interface requirements.

The algorithm detects when the projected capacitive touch signal becomes erratic, potentially indicating the sign of moisture on the display cover and switches the location detection priority to the force sensor. This augmented information is presented to the end-application or device operating system, such as Android or Microsoft Windows, using conventional drivers and libraries.

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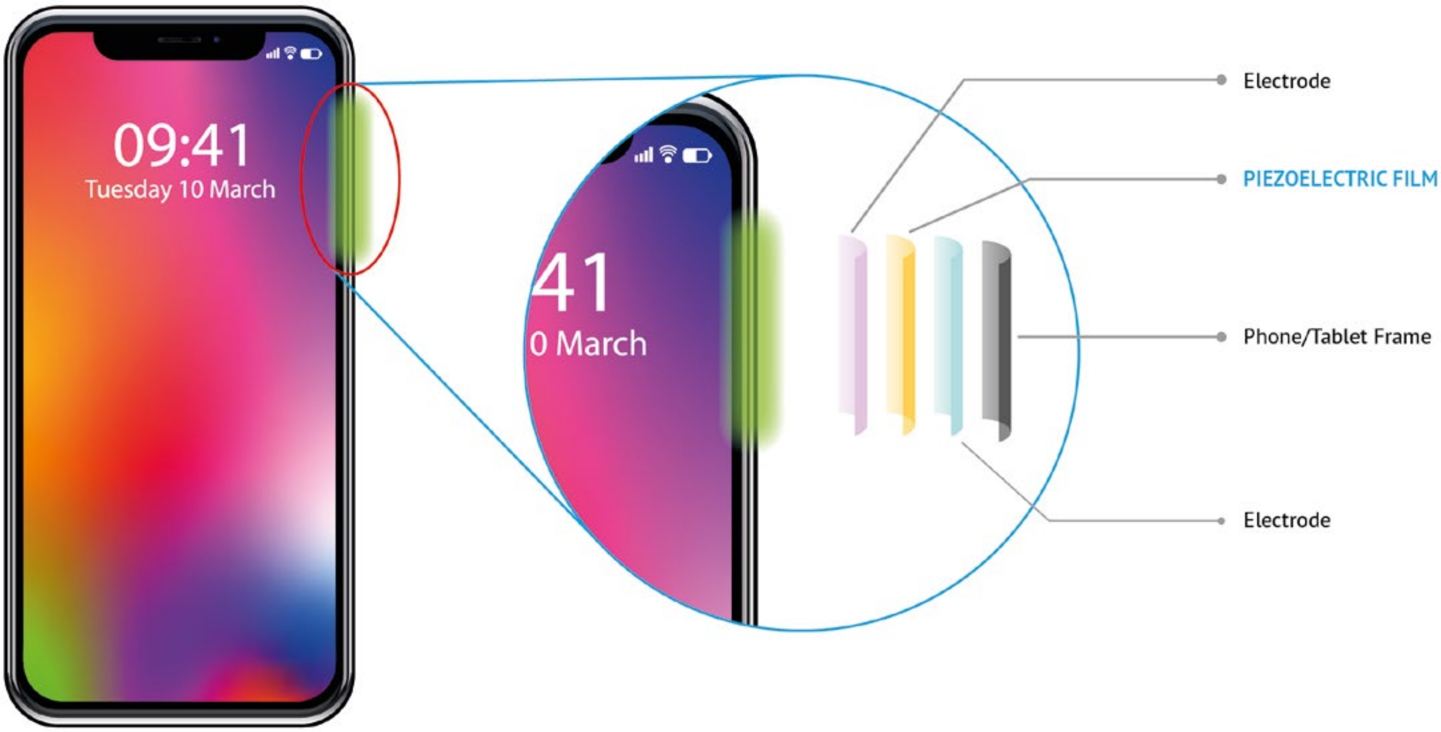

Figure 3 - Potential use case showing force sensing for button replacement

Getting started with UltraTouch

To aid the prototyping of UltraTouch developments a comprehensive evaluation kit (EVK) is available.

The UltraTouch EVK is a powerful, USB-powered, simple to use reference design to allow development engineers to experience first-hand how UltraTouch works, and how it can be used to design compelling end-products. The evaluation board contains a smartphone-sized PCB with multi-functional areas to test and evaluate buttons, sliders, and gestures, such as using a two-finger pinch.

Unlike other touch display EVKs available on the market, the UltraTouch EVK provides the ability to alter the force thresholds to demonstrate the behavior of a mechanical button. A raised border around the two-finger pinch area can be filled with a small amount of water to test and experiment with button and gesture operation under a film of water.

Complementing the EVK is a software tool, UltraTouch Studio*, that allows the configuration of various UltraTouch settings, such as pressure, button tapping frequency, and the force profiles of functions when activated. If the designer wishes to go further, more features and design tools can be unlocked with a license upgrade that can be acquired online and completed remotely.

** Microsoft Windows compatible*

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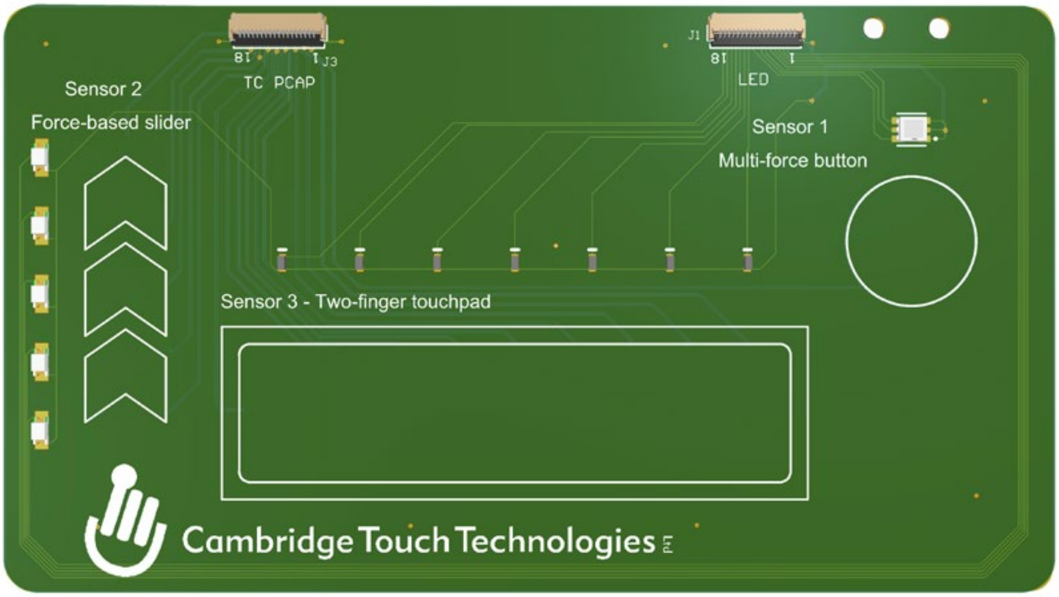

Figure 4 - The UltraTouch Evaluation Kit (source: Cambridge Touch Technologies)

The benefits of UltraTouch include:

- Reliable operation with wet fingers or gloved hands
- Supports the use of a non-conductive stylus
- Can operate when immersed in water *(For EVK only: thin-film of non-saline water)*
- Compatible for use in safety applications → configurable force thresholds for buttons
- Can replace projected capacitive touch technology in certain applications
- Uses a thin stack-up and is lightweight
- Readily adaptable to replace unreliable mechanical buttons
- Robust and solid state → no moving parts, no gaps, no MEMS that can break
- Easily manufactured and scalable
- Reduced bill of material and lower assembly costs
- UltraTouch can be used for conformal, flexible, bendable or flat applications → a wipe-clean surface makes it hygenic
- May be transparent if desired *(please discuss with Cambridge Touch Technologies technical team)*
- Force detection range – 0.5 N to 10 N *(EVK = 0.5 N to 2 N)*

The UltraTouch EVK will shortly be available for purchase from the Cambridge Touch Technologies website. Simple to use setup instructions are included together with technical and development support via email.

Next steps

Is your new product development team continually looking for new innovations to incorporate into your next generation product line-up? Could force detection, mechanical button replacement and underwater operation provide the product differentiation you seek? If so, the UltraTouch EVK is a low-cost and simple-to-use way of validating the ease with which force detection could be added to current and future products.

Once a prototype design has been developed with the EVK, the Cambridge Touch Technologies team and our network of trusted supply partners in Asia are ready to support you to bring your design into production.

First sales of the EVK are expected early 2021. To add your name to the pre-sale waiting list please e-mail *info@camtouch3d.com.* CTT will then contact you as soon as the kits become available.

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