Display Week 2011 Review: Touch Technology

2011 was the year that projected capacitive became the dominant touch technology in terms of revenue, and this was evidenced by its overwhelming dominance on the show floor.

by Geoff Walker

TOUCH continued to take an increasingly important role at Display Week 2011, with almost 40% of the approximately 200 exhibitors being directly or indirectly related to touch. There were 37 companies showing touch modules or controllers (compared with 33 last year) and 38 (*vs*. 34) companies showing related products such as adhesives, transparent conductors, glass, films, coatings, filters, bonding services, haptics, styli, touch monitors, touch-integration services, market-research reports, manufacturing start-up support, IP sales, and newsletters.

Projected capacitive (pro-cap) was by far the most frequently shown touch technology, as shown in Table 1. Twelve touch technologies were shown by the 37 exhibitors, with analog resistive and multi-touch resistive taking the second and third spots. This is quite representative of the real world, since pro-cap and resistive are expected to account for more than 95% of the world's total touch-screen revenue in 2011.

Projected Capacitive

Perceptive Pixel announced a 27-in. projected-capacitive touch monitor at Display Week 2011 (shown in Fig. 1). Jeff Han, the founder, president, and CEO of Perceptive Pixel, is well known for his conference presentations over the last several years (including at Display Week 2010) during which he has complained that the touch industry's habit of settling for the minimum acceptable performance is a harbinger of serious future problems. Jeff decided to show the industry how to do it right – *i.e.*, put performance first. His 27-in. monitor is exceptional, starting with a 2560 × 1440 (109 dpi) premium IPS-LCD. The touch screen uses a 32-in. piece of glass; this "intentional overscan" beyond the edge of the 27-in. LCD creates a significant advantage in usability. For example, touching a close-window button in the upper-right corner of the screen becomes much easier because one can touch anywhere above or to the right of it in the "overscan margin" of the touch screen.

The key to the monitor's performance is the custom pro-cap controller developed by Perceptive Pixel. The controller implements the absolute minimum hardware necessary to collect the data that comes out of the sensor and puts everything else in software, along with a large amount of signal processing. This makes it much easier to tune the controller's design for absolute maximum performance (*e.g.*, the 1-msec touch-response time that Perceptive Pixel claims, which leaves everyone else – including 3M Touch, the former performance leader – in the dust).

Roll-Your-Own Controller

Perceptive Pixel, developing its own pro-cap controller, is actually symptomatic of a trend that is occurring in the touch industry. At

Table 1: Twelve touch technologies were shown by the 37 companies exhibiting touch modules or controllers at Display Week 2011. The total adds to more than 37 because many companies showed multiple technologies.

Touch Technology	Exhibitors
Projected Capacitive	23
Analog (Single-Touch) Resistive	13
Multi-Touch Resistive	6
Surface Acoustic Wave (SAW)	3
Infrared (IR)	2
Electromagnetic Digitizer (EMR)	2
In-Cell	2
Surface Capacitive	1
Dispersive Signal Technology (DST)	1
Acoustic Pulse Recognition (APR)	1
Camera-Based Optical	1
Force-Sensing	1
TOTAL	**56**

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Fig. 1: *Jeff Han, the founder, president and CEO of Perceptive Pixel, shows off his brand-new 27-in. pro-cap multi-touch monitor. Photo courtesy Geoff Walker.*

least 40% of the software inside pro-cap controllers sold by major suppliers such as Atmel and Cypress is typically totally proprietary; *i.e.*, the source code is not available to an OEM customer under any circumstances. Integrating a pro-cap touch screen is still somewhat of an art rather than a science, and the lack of access to source code can create a significant barrier when "tweaking" the match between the sensor and the controller. If an OEM customer is buying multiple millions of controllers (*e.g.*, for a smartphone), the controller supplier simply provides whatever amount of on-site field-applications-engineering (FAE) resource is required to solve any problems.

But what if the OEM customer is a medical-device manufacturer that's making only tens of thousands of devices? The major controller suppliers simply cannot afford to support such a small customer. In response to this situation, a number of pro-cap module suppliers are developing their own controllers. Apex Material Technology (AMT) is an example of such a supplier; taking this approach allows the company to supply a complete, integrated touch solution that it can fully support. Even TPK, the largest supplier of pro-cap in the world, has developed its own controller.

Yet another example of this trend is 3M Touch – which announced at Display Week 2011 that the pro-cap touch screens used in its high-performance touch monitors are now available as components. This leading-edge product consists of two patterned-ITO films manufactured on 3M's own roll-to-roll equipment and laminated to the back side of a sheet of glass, along with a 3M-developed controller. While 3M's initial focus for these new components remains on vertical markets, the company is confident that continued cost-reduction in its manufacturing processes will allow it to meet the price points demanded by consumer electronics manufacturers in Asia.

This trend can be viewed as a good-news/bad-news situation. The good news is that it is enabling pro-cap technology to spread quickly to all sizes of customers; the bad news is that it is probably prolonging the time it will take for pro-cap to reach the level of standardization enjoyed by mature touch technologies.

Other Interesting Pro-Cap Exhibits

NEC LCD Technologies (through its U.S. representative, Renesas Electronics America) demonstrated a prototype of a 10.4-in. SVGA industrial LCD with fully integrated touch. The touch screen in this product is on-cell pro-cap, meaning that the sensor is located on the top surface of the color-filter glass, underneath the polarizer. The most unusual aspect of the product is that the controller (apparently designed by NEC, in another example of the previously described trend) is totally contained within the LCD's standard-sized frame. This makes the integrated touch display a drop-in replacement for existing displays.

There were two other examples of on-cell touch on the show floor, one from Sharp and one from LGD. The latter was in a 3.2-in. IPS-LCD. IPS makes doing on-cell touch more difficult, since the primary noise source is closer to the touch sensor. LGD claims a 20:1 signal-to-noise ratio for its design, which is about double that typically reported for in-cell and about half that typically reported for add-on (out-cell) technology. LGD believes that it can scale its on-cell technology to 22 in. without difficulty – although nobody has actually done it yet, particularly with IPS.

Touch International showed a 10.4-in. pro-cap touch screen made on a sheet of 0.7-mm cover glass. The sensor consisted of two ITO-PET films laminated to the back of the glass; the glass also had logos on it and holes drilled in it. Touch International said that in volumes of 25K, this configuration would sell for $35–$40 – which is actually quite economical, considering the underlying current market price of $3 per diagonal inch for plain pro-cap with no decoration.

Zytronic showed a 10.4-in. ITO-based pro-cap touch screen that represented a significant change for the company, since it has long been a proponent of wire-based pro-cap. A booth representative said that the change was

driven by a desire to be able to participate in higher-volume vertical applications.

Wacom finally launched its 22-in. pro-cap touch screen (with its own custom controller) at Display Week 2011. This is a significant milestone because the company has been showing it in prototype form since November of 2008. Performance of the product is decent for a 22-in. screen; Fig. 2 illustrates the response in a worst-case test (top: 10 fingers drawing circles as quickly as possible) and an average-case test (bottom: two fingers, one drawing circles at a moderate pace while the other one writes the letters A-B-C).

N-trig provided a refreshing change at Display Week 2011. Instead of displaying its dual-mode (pen and finger) pro-cap touch-screen hardware, it focused on showing off some of its OEM customers' products. The most interesting product was the HTC Flyer, a 7-in.,very thin (0.5-in.) Android tablet currently selling at Best Buy for $499 (see Fig. 3). While the appearance of the product is very appealing, HTC's implementation of N-trig's touch screen is less so in that it is entirely modal; *i.e.*, the user must manually select either pen or finger mode as desired. This is a very clumsy user interface compared with the elegant automatic mode-switching implemented by some of N-trig's other OEMs.

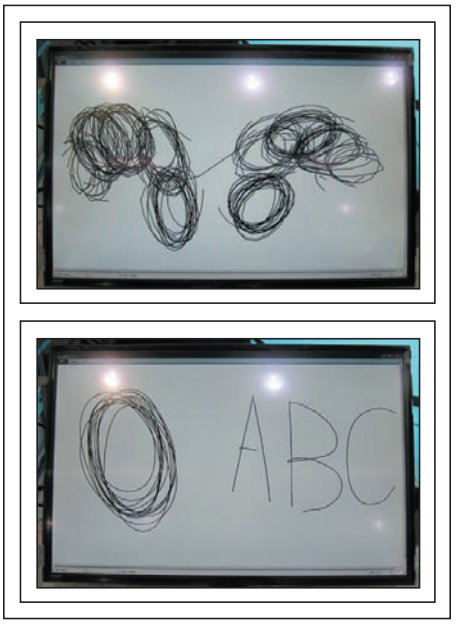

Fig. 2: *Top: Wacom's 22-in. pro-cap touch screen shows a worst-case test with 10 fingers drawing circles as fast as possible. Bottom: An average-case test uses two fingers, one drawing circles at a moderate pace while the other writes the letters A-B-C. Photo courtesy Geoff Walker.*

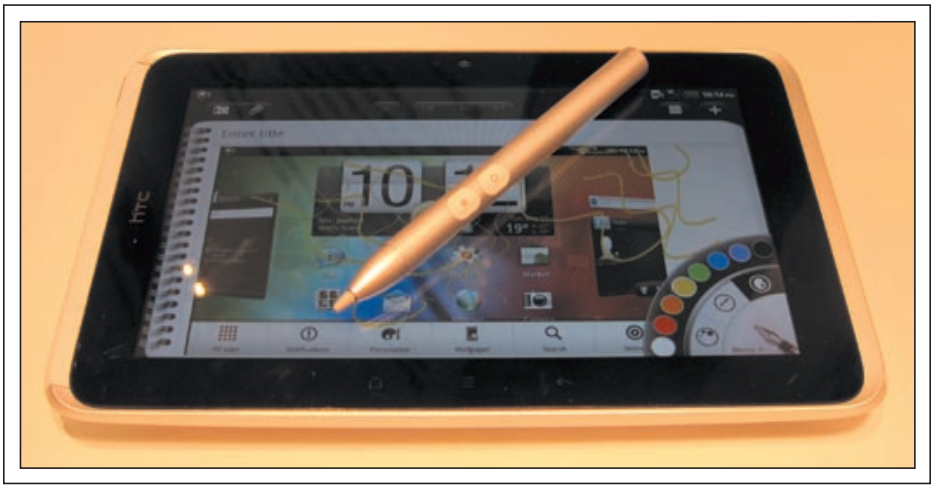

Fig. 3: *The HTC Flyer Android tablet with a 7-in. display and N-trig's dual-mode (pen and finger) pro-cap touch screen. With the product thickness at only 0.5 in., there is no internal storage for the stylus. Photo courtesy Geoff Walker.*

In-Cell Touch

Not much is happening yet commercially with in-cell touch technology. The only two examples shown at Display Week 2011 were prototypes from Samsung and Toshiba. Samsung showed its 40-in. Interactive Display, developed jointly with Microsoft as the basis for Microsoft's second-generation Surface product (announced in January 2011). This is a 1920 × 1080 (55 dpi) LCD with optical in-cell touch, branded by Samsung and Microsoft as "PixelSense." Samsung's main breakthrough in this product is that it uses one sensor per pixel (that's 2M sensors!), something that nobody else has been able to accomplish without significant loss of aperture.

Interestingly, Samsung's demonstration included a secondary display that showed the output of the sensor array (presumably infrared light converted to visible light). Figure 4 shows the effect of touching the 40-in. display with a flat palm (top) versus just the fingertips (bottom).

The only other example of in-cell touch at Display Week was a 7-in. 1024 × 600 LCD by Toshiba that employed a variation of in-cell capacitive. Instead of measuring the change in capacitance between two internal electrodes

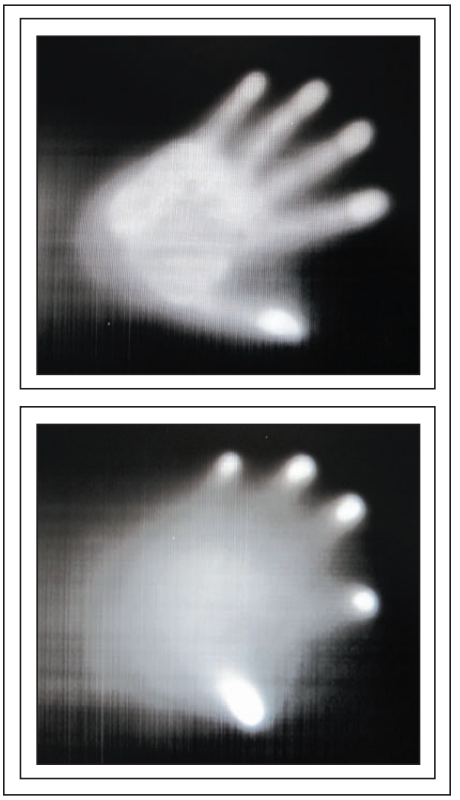

Fig. 4: *These photographs show the sensor-array output (displayed on a secondary LCD) from Samsung's 40-in. in-cell optical ("PixelSense") LCD. Top: The author's palm flat against the display. Bottom: Fingertips only. Photo courtesy Geoff Walker.*

due to the change in dielectric constant of the liquid-crystal material that results from the pressure of the user's finger, Toshiba's scheme measures the change in capacitance of a single electrode due to the addition of the user's body capacity. The scheme uses one sensor per 16 pixels, which is typical of most in-cell implementations (other than Samsung's). Unfortunately, the author was unable to make the demo function properly; it would not even consistently recognize two touches, even though the demo signage said that the display was capable of recognizing 10 touches.

Other Touch Technologies

Hanvon's new dual-mode (pen and finger) electromagnetic resonance (EMR) digitizer was the only totally new touch technology announced at Display Week 2011. Hanvon is a well-known supplier of EMR digitizers; the company competes with Wacom in applications such as pen systems for eReaders. Hanvon's breakthrough is the addition of an array of pressure-sensing piezo capacitors to the existing EMR sensor (see Fig. 5). These are very similar to the capacitors used as the pressure sensor in the tip of the digitizer pen, so in a sense it is like replicating a portion of the pen circuit on the sensor board beneath the display. The operation of the pen is unchanged; the addition of the capacitors allows finger pressure to be sensed through the electronic-paper display (EPD). This is a particularly good solution for touch on e-Readers because nothing is added on top of the EPD, which relies entirely on reflected light for its operation. None of the touch technologies currently used in eReaders (resistive, pro-cap, infrared, and EMR digitizer) offer this combination of high-resolution stylus and light-pressure finger touch. In the author's opinion, this new touch technology is likely to gain significant traction in the eReader space.

F-Origin's force-sensing touch technology was a welcome addition to Display Week 2011. During 2010, F-Origin had contracted down to only one person; with the infusion of an investment and a partnership with TPK, it is now back on a growth path. The company is also on its second major generation of technology. In the previous implementation, the display was supported by strings of monofilament; in the latest, it is supported by two metal suspension spring arms (see Fig. 6), which seems to be a much more robust approach.

Elo TouchSystems, now a trademark of TE Touch Solutions (a business unit of TE Connectivity, formerly called Tyco Electronics), focused attention on its latest innovation, a two-touch zero-bezel SAW touch screen and monitor. Performance was very good, showing significant improvement over the previous non-zero-bezel generation. In support of its basic "touch-technology agnostic" positioning, Elo also showed a set of hand-sized samples of six of its touch technologies. While this isn't rocket science, it is good (and fun) marketing. The samples made very clear the

Fig. 5: *In Hanvon's dual-mode (pen and finger) EMR digitizer, the sensor board (labeled "ERT unit") is shown inserted between the electronic-paper display (EPD) and the motherboard in an e-Reader. The circles shown on the sensor board represent one column of an array of force-sensing piezo capacitors. Image source: Hanvon.*

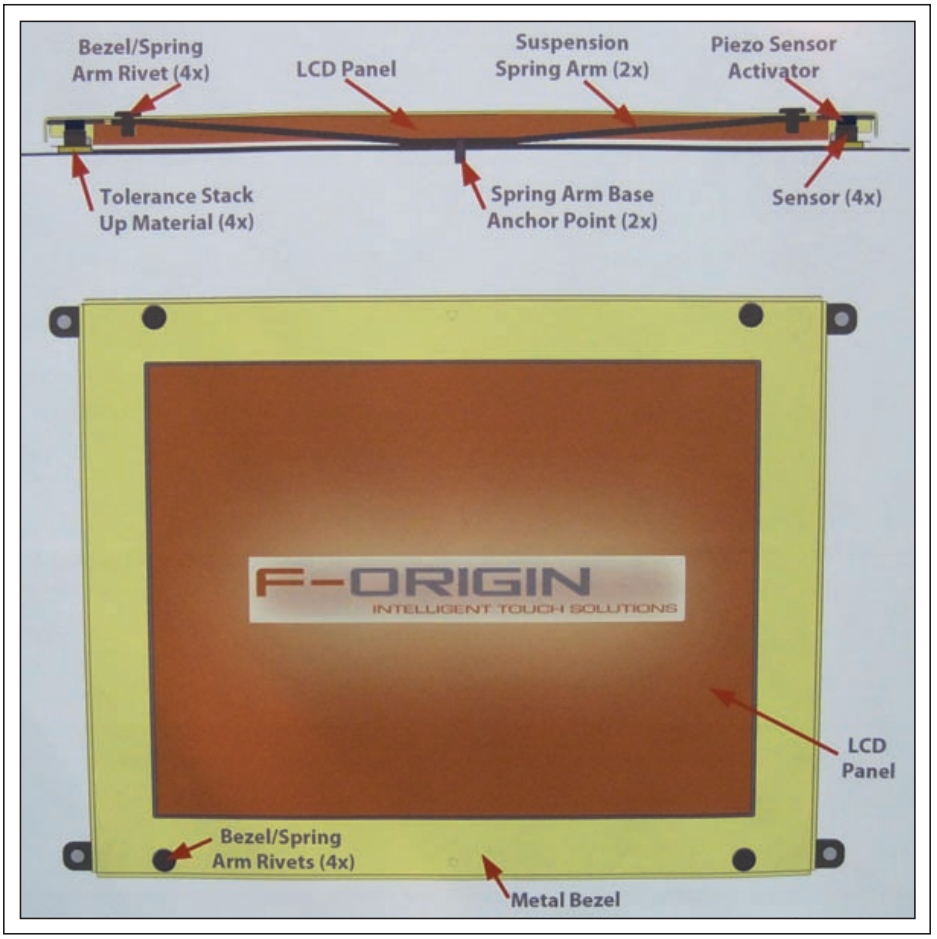

Fig. 6: *F-Origin's force-sensing touch technology uses metal spring arms to support the LCD and constrain its movement to only the Z-direction. Image source: F-Origin.*

physical differences in the touch technologies, something that's often valuable for newcomers to experience.

Other Interesting Bits

As previously shown in Table 1, there were six companies demonstrating multi-touch resistive. However, none of them would admit to winning any significant amount of business with the technology, at least not in the consumer-electronics space. The problem seems to be that it is very difficult to compete with the pro-cap express train, even at two-thirds the cost.

Baanto was the only supplier of camera-based optical touch exhibiting at Display Week 2011. While the performance it demonstrated was definitely a significant improvement over its 2010 performance, in the author's opinion it was not significantly better than that of competitors such as NextWindow and Quanta.

Fujitsu showed a new version of its four-wire resistive touch controller that included integrated two-point "gesture touch" – *i.e.*, multi-touch that works well for gestures such as pinch/zoom but does not actually meet the Microsoft Windows 7 touch-logo requirements. Unfortunately, the demo/prototype gods were not kind to Fujitsu; when the author tried it, the two points could not be recognized if they were closer than about two inches.

Summary

Once again, there was an amazing amount of touch technology at Display Week 2011, probably more than at any other conference worldwide in the last year. This is especially clear when one considers the additional touch resources at Display Week beyond the exhibits, including the Symposium touch papers, the Sunday Short Course on touch, the two Monday Seminars on touch, the Wednesday SID-IMS conference ("The Future of Touch and Interactivity"), and, finally, the Thursday touch posters. There was so much touch at Display Week 2011 that it was actually overwhelming. ■