Touch Technology for eReaders

Four touch technologies are currently used in eReaders: analog resistive, electromagnetic pen digitizer, scanned infrared, and projected capacitive. None of these meet 100% of the user and system requirements for optimum touch in eReaders.

by Geoff Walker

WITH MORE THAN 500 million people using smartphones and tablets equipped with projected-capacitive touch technology, a *de facto* standard has arisen for what users expect on any touch-capable mobile device – including eReaders. The key requirements of this standard include the following:

- Extremely light touch
- Fast response
- High accuracy for selection
- Multi-touch for zoom (with images stored at higher resolution)
- Flush bezel for a high-tech look.

The touch usage model of eReaders adds another requirement: annotation capability. At the minimum, this means high-resolution digital ink for good readability; ideally, it includes handwriting recognition for automatically converting ink annotations into text.

The primary characteristic that differentiates a dedicated eReader from a tablet is the use of an electrophoretic display, often referred to as an "electronic-paper display" (EPD). EPDs are reflective displays, so the light that produces the image seen by the user must travel twice through whatever layers are on top of the display. This puts a premium on touch screens with very high transmissivity. Low reflectivity of the touch screen is also very important, since reflected light reduces the image contrast.

Additional system-level requirements for touch screens in eReaders include the following:

- Very low power consumption (like that for EPDs)
- Light weight, ideally achieved with no added glass layer
- Durable surface for annotations.

Four Current Touch Technologies

There are four touch technologies currently used in eReaders (see Fig. 1), as follows in order of decreasing popularity:

- ***Analog resistive*** (*e.g.*, in the Sony PRS-600 and many others)
- ***Scanned infrared*** (*e.g.*, in the Kindle Touch, the Nook Simple Touch, the Sony PRS-950, and a number of others)
- ***Electromagnetic pen digitizer*** (*e.g.*, in the Onyx Boox M90, the Hanlin V90, the Hanvon WISEreader E920, which adds finger touch, and several others)
- ***Projected capacitive*** (*e.g.*, in the Pixelar MReaders, the Hanlin V60T/V61T/A6/A9, the Kogan Reader, and a few others)

Analog Resistive: While resistive is commonly used in touch eReaders because of its low cost, it is actually the worst choice. Transmissivity is typically in the 80–90% range, which means that up to 40% of the light can be lost during its two trips through the touch screen. Because there are four reflective surfaces in a resistive touch screen, reducing surface reflectivity is very expensive. Resistive requires a relatively heavy touch, but works well with a passive stylus – except that the lack of palm rejection makes annotation difficult. Resistive as used in eReaders today provides single-touch only. Resistive is available in an "almost-flush bezel" form in which the touch-screen's plastic cover sheet is extended to cover the entire top surface of the product.

Scanned Infrared: Infrared (sometimes called "optical") touch technology has not historically been used in mobile products. However, one company (Neonode in Sweden) has made significant progress in miniaturizing infrared touch components over the past half-dozen years, with the result that it is currently the only supplier of infrared touch in eReaders. (Neonode's patent portfolio provides a significant barrier to entry for other suppliers.) Infrared's major advantage in an eReader is the lack of need for a substrate. This is ideal for use with a reflective EPD, since no light is lost. On the other hand, sensing touch with infrared requires breaking a matrix of light beams that are present above the surface of the display, so a flush bezel is not possible. Conventional infrared is relatively low resolution, so annotation with a stylus typically is not very satisfying, and multi-touch is generally limited to two not-very-robust touches. Infrared is susceptible to unintended touches from contaminants (or if the user forgets to turn off the device before putting it in a briefcase) and from ambient IR radiation.

Electromagnetic Pen Digitizer: Pen digitizers have been used in mobile products for

Geoff Walker *is the Owner & Principal Consultant at Walker Mobile, LLC, and Principal Analyst for Touch at IMS Research. He has been* Information Display*'s Guest Editor for Touch since 2007 and is a recognized touch-industry expert. He can be reached at 408/945-1221 or geoff@walkermobile.com.*

0362-0972/03/2012-030$1.00 + .00 © SID 2012

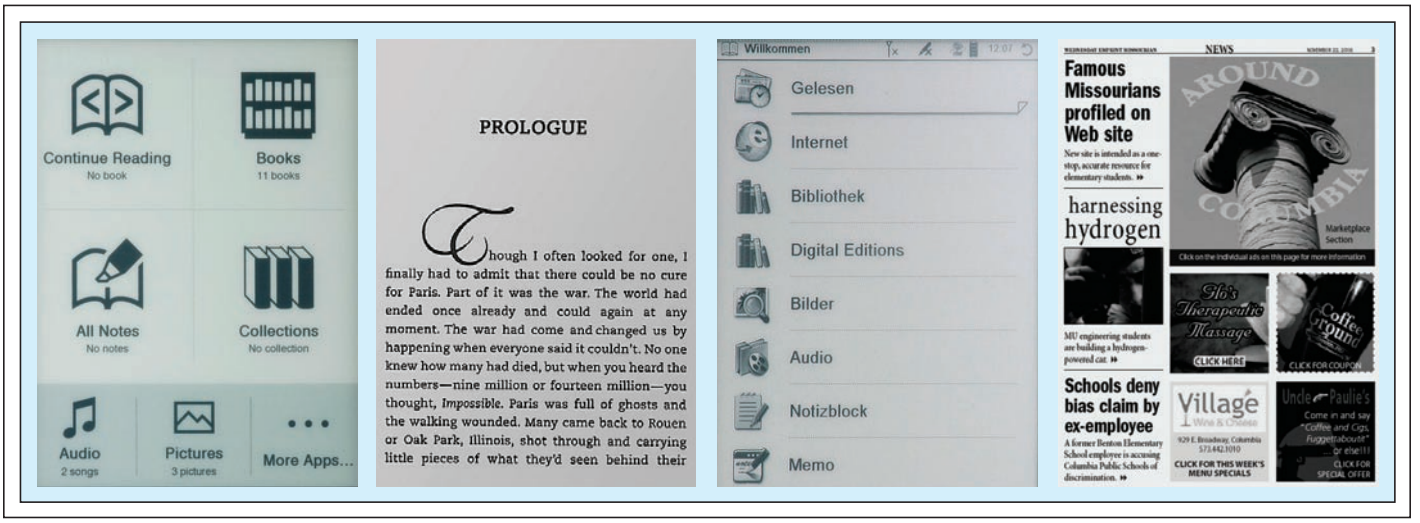

Fig. 1: *Four 6-in. eReaders are shown, one with each touch technology (left to right): Sony's PRS-600 (resistive), Amazon's Kindle Touch (infrared), Hanvon's N618 (electromagnetic pen digitizer), and Jinke's Hanlin A6 (projected capacitive). Most eReader manufacturers offer only one or two touch technologies; Jinke in China is the only one that offers all four. Source: Manufacturers.*

over 20 years, so it is not surprising that they are used in some eReaders. Like infrared, this technology's major advantage is its lack of a need for a substrate (the digitizer's sensor goes behind the EPD, so no light is lost). Since there is no touch-screen substrate, the possibility of a flush bezel depends on the design and construction of the EPD. Pen digitizers are typically very high resolution (often as high as 1000 dpi) with inherent palm rejection, which makes them very well-suited for annotation. However, with the exception of Hanvon's "Dual-Touch" technology (which supports both pen and single-touch finger), pen digitizers are pen-only.

Projected Capacitive: "Pro-cap," as it is often called, is the touch technology used in most smartphones and tablets today. However, it is relatively expensive (a 9-in. pro-cap touch screen is typically 3× the cost of resistive), so it is less frequently used in eReaders. Pro-cap's advantages are its very light touch, multi-touch, and flush-bezel capability – all of which are characteristics of the *de facto* standard, so usage is likely to increase despite the cost. Currently, it is finger-only, so annotation is not possible (although some pro-cap touch-screen suppliers will start supporting both active and passive styli during 2012). When stylus support arrives, pro-cap is capable of providing good palm rejection, so the user's annotation experience can be almost as good as with a pen digitizer. Light loss is not a major issue with pro-cap, since transmissivity is in the 95–98% range. However, limiting the reflectivity of the touch screen's top surface adds even more cost. Two of the three sample eReader suppliers listed under pro-cap on the previous page use the SiPix/AUO EPD; this form of pro-cap uses two patterned-electrode films laminated on top of the EPD during manufacturing and is covered with a hard coat (*i.e.*, no glass). While the cost of this form is relatively low, future stylus support seems unlikely.

Power Consumption

Power consumption in an eReader is dominated by page-turns; *i.e.,* by changing the image on the EPD. The power consumption of all four of the touch technologies described in this article is orders of magnitude less than that of the EPD. While some power-consumption differences do exist between the technologies, experience has shown that the quality of the power-management algorithms used to control the touch screen is actually much more significant than the differences between technologies.

Emerging and Future Solutions

As noted earlier, none of the four touch technologies described here meet 100% of the user and system requirements listed in the beginning of this article. Of the four, the one that is the closest to meeting all the requirements is Hanvon's Dual Touch pen digitizer. Hanvon achieves finger touch by adding some low-cost components to the digitizer sensor behind the EPD; if Hanvon can meet its goal of supporting touch with multiple fingers, the only remaining negative will be the electronic (but batteryless) stylus.

Another technology that has a good chance of meeting all the requirements is waveguide infrared. Created by RPO in Australia and branded "Digital Waveguide Touch" (DWT), it is essentially a lower-cost and higher-performance version of scanned infrared. Unfortunately, RPO shut down due to lack of funding during 2011 and its extensive patent portfolio is currently for sale. It is possible that the technology (which was very close to mass production) may be purchased and made available by another touch supplier.

There is one additional touch technology that has at least some chance of meeting all the requirements once it becomes more mature. The technology is TE Connectivity's (Elo TouchSystems') Acoustic Pulse Recognition (APR). APR is capable of pen and finger touch with nothing added in front of the display. E Ink has done some prototyping of APR integrated into its EPD, but it is too early to determine the potential. ■