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Touch Technologies for eReaders

Geoff Walker
Principal Analyst
IMS Research

September 29, 2011

Agenda

- **Touch-Usage Requirements [1]**
- **System-Level Requirements [1]**
- **Current Touch Technologies [4]**
  - Electromagnetic resonance pen digitizer (EMR), capacitive, traditional infrared, and resistive
- **Emerging Touch Technologies [2]**
  - EMR with integrated force-sensing [Hanvon]
  - Waveguide infrared [RPO]
- **Potential Touch Technologies [3]**
  - Traditional force-sensing, Acoustic Pulse Recognition/ ReverSys [Elo], and embedded (“in-cell/on-cell”)
- **Conclusions [1]**

[Total = 12]

Touch-Usage Requirements
(EPD-Based Devices Only!)

- **Selection**
  - High accuracy
- **Swipes**
  - Very light touch & fast response (iPhone set the standard)
- **Zoom**
  - Multi-touch
    - *Better with images stored at higher resolution than displayed*

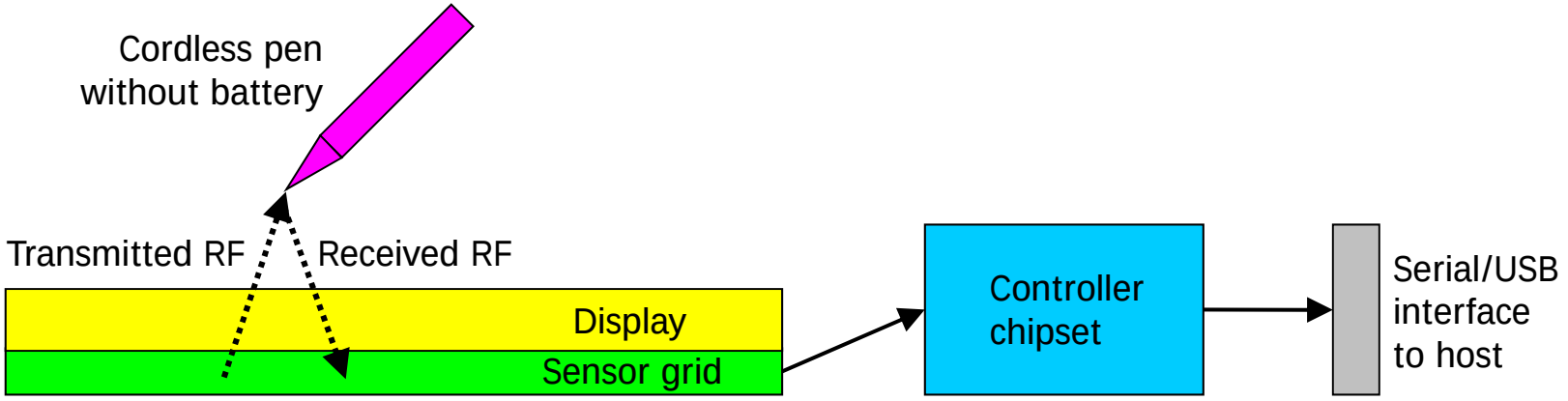
- **Annotation**
  - Stylus with palm rejection
    - *Better with software infrastructure for saving annotations with location in text, even when text is reflowed*
  - High-resolution ink for readability
  - Desirable: Handwriting recognition (conversion from ink to text)

System-Level Requirements
(EPD-Based Devices Only!)

- **Zero light loss (eReader = EPD!)**
  - Transmissivity: Light goes through the touch-screen twice!
  - Reflectivity: Reflected light reduces image contrast
- **Very low power consumption**
  - Typical usage model doesn't help
- **Durable & light weight**
  - Very Desirable: No added glass
  - Hard surface for annotations
- **Insensitive to ambient light**
  - Works in bright sunlight with lots of IR

Current Touch Technologies…1
(Being Shipped Today in e-Readers)

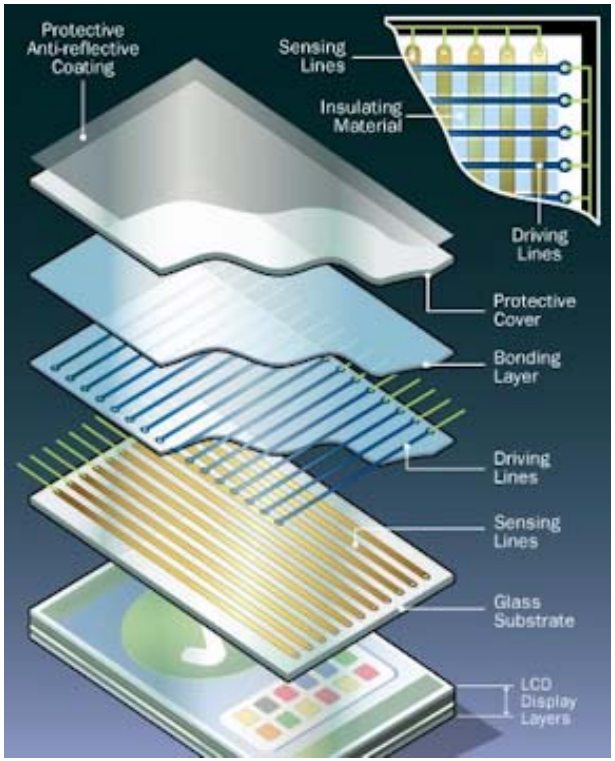
- **Electromagnetic resonance pen digitizer (EMR)**
  - Most common “touch” technology in eReaders
    - Wacom & Hanvon are primary suppliers
  - Sensor goes behind EPD, so no light loss
    - But NO finger touch, and electronic pen is at risk for being lost
  - High resolution ink & inherent palm rejection
  - Lack of infrastructure reduces value of annotation today



Source: Author

Current Touch Technologies…2
(Being Shipped Today in e-Readers)

- **Capacitive**
  - Same technology as in iPhone & 100% of tablets
  - Light touch & multi-touch
  - Surface can be flush (“zero-bezel”)
  - Light loss can be minimized to 2-4%
  - Finger-only (so far), so no annotation
    - Palm rejection is achievable when stylus arrives
  - Still very expensive: 7” ≈ $25 OEM cost with controller (film/film/cover-glass)
    - AUO/SiPix is using laminated film/film/no-glass with a hard-coat cover film



Source: HowStuffWorks.com

Current Touch Technologies…3
(Being Shipped Today in e-Readers)

- **Traditional infrared (for mobile)**
  - Only one supplier today: Neonode (Sweden)
    - Small company licensing IP, not selling hardware
  - Used in Sony, Koobe, Nook Simple Touch, and maybe others
  - No glass, so no light loss
    - IR beams above EPD surface ➔ non-flush bezel
  - Relatively low resolution
  - Doesn't scale very well

Source: Neonode and Pen Computing Magazine

Current Touch Technologies…4
(Being Shipped Today in e-Readers)

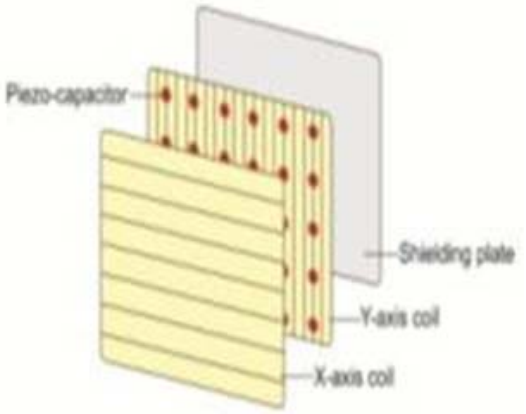
- **Resistive on top of EPD**
  - All single-touch today
    - Nobody has announced the use of multi-touch resistive yet; it seems unlikely because it's not enough of an improvement
  - Least desirable current technology
    - 15% to 20% light loss (glass + 2xITO + PET + air-gap)
    - Reducing surface reflectivity is expensive
    - Requires heavier touch
    - No palm rejection

Source: Sony

- **Resistive *underneath* EPD**
  - Demonstrated by E-ink at SID 2010
  - Potential solution, especially once EPD backplane becomes totally flexible

Emerging Touch Technologies…1

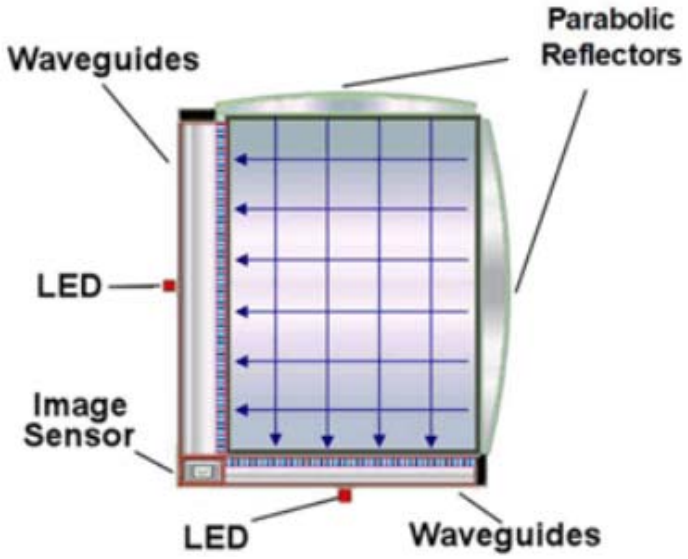
- **Hanvon's EMR + force-sensing**
  - **High-resolution stylus plus finger-touch**
  - Adds an array of piezo-capacitors (used in pen tip to sense pressure) to EMR sensor behind EPD display
    - EMR controller enhanced to support force-sensing ➔ still one chip
    - Nothing added in front of display ➔ no light loss
    - Very light touch (under 10 grams)
    - Palm rejection with auto-switch between pen and finger
    - Multi-touch planned by end of 2011
    - Fast response (200 pps)
    - Low cost & low power consumption
  - Will be validated in Hanvon-branded products first, then released to market



Source: Hanvon

Emerging Touch Technologies…2

- **Waveguide infrared ("Digital Waveguide Touch")**
  - Only one supplier (RPO), ***and their IP is on the market***
  - At least one major eReader OEM had committed to use them
    - That OEM (or someone else) may buy the IP & other assets, and the technology may survive
  - Good solution for eReaders
    - Light guide (glass or plastic) underneath the EPD, so no light loss
    - Zero-force touch & multi-touch
    - Very low power consumption
    - Higher resolution ➔ finger or stylus
    - Easily scalable up to 14"
    - Very good ambient light rejection



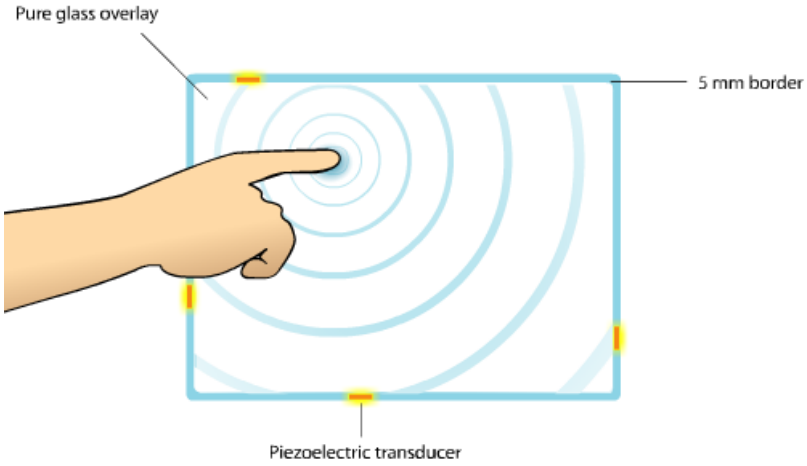
Source: RPO

Potential Touch Technologies…1

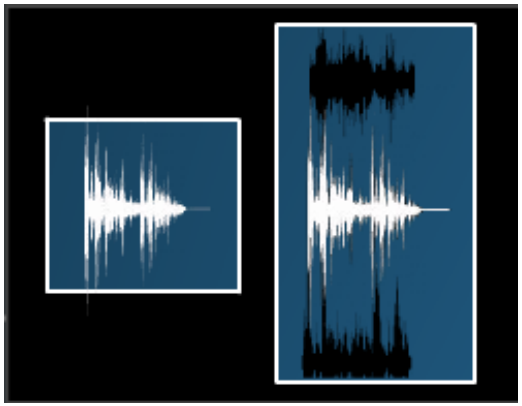
- **"Traditional" force-sensing**
  - **FloatingTouch, LLC (early-stage startup)**
    - Any-touch with nothing added in front of display
    - Display mounts on 2-mm flexible adhesive pad that contains sensors
    - May support multi-touch & palm rejection (TBD)
  - **Impress (spin-off from Pressure Profile Systems)**
    - Similar concept to FloatingTouch

Potential Touch Technologies…2

- **Elo's Acoustic Pulse Recognition (APR) + Sensitive Object's Reversys**
  - Any-touch with nothing added in front of display
  - Prototype with piezos integrated into E-ink display
  - Second generation of combined technology is still under development
  - Too early to determine if it meets all the requirements



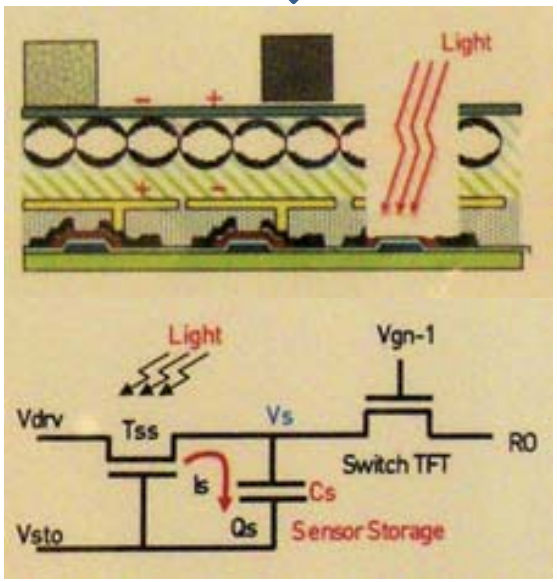
Source: Elo TouchSystems



Source: Sensitive Object

Potential Touch Technologies…3

- **Embedded in EPD backplane ("in-cell")**
  - Light-sensing: LGD showed concept at SID 2009
    - Visible light ➔ Can't touch black object
    - IR light ➔ No reliable source
  - Voltage-sensing: ***Not possible***
    - Depends on micro-switches between top & bottom of rigid cell
  - Charge-sensing: ***Not possible***
    - Depends on change in dielectric constant of LC material



Source: LG Displays

- **Deposited on EPD frontplane ("on-cell")**
  - Charge-sensing: Possible with 2nd film layer for protection

Conclusions

eReader Touch Technology	Current Usage/Status*	Geoff's Rating	Comment
EMR Pen Digitizer	**15%**	**B**	No finger-touch
Capacitive	**25%**	**B**	No stylus (yet)
Traditional Infrared	**40%**	**B**	Low resolution & scalability
Resistive (on top of EPD)	**17%**	**D**	Worst choice (but low-cost)
EMR + Resistive (on top)	**3%**	**C**	Only Samsung (expensive)
Hanvon's EMR + Force-Sensing	Close	**A**	Needs real-world validation
RPO's Waveguide Infrared	IP For Sale	**A**	Will the technology survive?
FloatingTouch's Force-Sensing	Development	**B**	Potentially very low-cost
Impress' Force-Sensing	Development	**B**	Potentially very low-cost
Elo's APR + ReverSys	Development	**C**	Long development cycle
Capacitive on Frontplane (on-cell)	Concept	**B**	Still some light-loss; stylus?
Resistive (underneath EPD)	Concept	**D**	Expensive force-sensing
Embedded in Backplane (in-cell)	Concept	**D**	No apparent solution

* Shipment share of eReaders with touch (author's estimates)

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Thank You!

Geoff Walker
geoff.walker@imsresearch.com
+1 408-945-1221 office
+1 408-506-7556 mobile

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IMS Research Europe
3-5 Huxley Close,
Wellingborough,
Northants,
NN8 6AB, England

T: +44 1933 402 255
F: +44 1933 402 266

IMS Research USA
3301 Northland Drive,
Suite 400,
Austin, TX 78731
USA

T: +1 512 302 1977
F: +1 512 302 1844

IMS Research China
Room 605, Tower B,
Orient Intl. Plaza,
85 Lou Shan Guan Road,
Shanghai, 200336, PRC

T: +86 21 6270 1823
F: +86 21 6270 1833

IMS Research Taiwan
6F-1, No.8, Lane 18,
Sec.1, Yunghe Rd
YungHe City, 234,
Taipei, Taiwan

T: +886 939 842 065

IMS Research Korea
Room 350
Gangbyeon Metro Center
Seongjin Bldg. 3F, 593-15
Guui-3-dong, Gwangjin-gu,
Seoul, Korea 143-831
T: +82 70 8661 2035
F: +82 2 6925 3810