ABSTRACT

E-paper is a revolutionary material that can be used to make next generation; electronic displays. It is portable reusable storage and display medium that look like paper but can be repeatedly
written one thousands of times. These displays make the beginning of a new area for battery power information applications such as cell phones, pagers, watches and hand-held computers etc.

Two companies are carrying our pioneering works in the field of development of electronic ink and both have developed ingenious methods to produce electronic ink. One is E-ink, a company based at Cambridge, in U.S.A. The other company is Xerox doing research work at the Xerox's Palo Alto Research Centre. Both technologies being developed commercially for electronically configurable paper like displays rely on microscopic beads that change color in response to the charges on nearby electrodes.

Like traditional paper, E-paper must be lightweight, flexible, glare free and low cost. Research found that in just few years this technology could replace paper in many situations and leading us ink a truly paperless world.

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INTRODUCTION

Today's electronic displays have ever more evolved to be more lightweight, efficient and clear. Yet the importance of the paper has not diminished. We still prefer it to others for a variety of reasons including its readability, high contrast, convenient handling, minimum power requirement cost and strainless reading it offers. At the same time, an electronic display offers us a paperless environment and relieves us from carrying loads of paper for referring to information when required.

Electronic ink is a pioneering invention that combines all the desired features of a modern electronic display and the sheer convenience and physical versatility of sheet of paper. E-paper or electronic paper is sometimes called radio paper or smart paper. Paper would be perfect except for one obvious thing: printed words can't change. The effort is to create a dynamic high-resolution electronic display that's thin and flexible enough to become the next generation of paper.

The technology has been identified and developed is well under way. Within five years, it is envisioned electronic books that can display volumes of information as easily as flipping a page and permanent newspapers that update themselves daily via wireless broadcast. They deliver the readability of paper under virtually any condition, without backlighting. And electronic ink displays are persistent without power, drawing current only when they change, which means batteries can be smaller and last longer.

Two companies are earning our pioneering works in the field of development of electronic ink and both have developed ingenious methods to produce electronic ink. One is E-ink. a company based at Cambridge, Massachusetts in U.S.A. The other is Xerox doing reseaici. work at the Xerox's Palo Alto Research Center. Big companies like Philips, p^gain books, Motorola, The Hearst Corporation, and Atlas Venture axe ftidi-g both. These are the companies who believe that electronic paper does have a f-V-re,

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E-PAPER TECHNOLOGY

rElectronic paper is also called as radio paper or smart paper or e-paper or electronic ink, is a display technology designed to mimic the appearance of regular ink on paper. Electronic paperare flects light like ordinary paper and is capable of holding text and images indefinitely without edrawing electricity or using processor power, while allowing the paper to be changed. One important feature needed is that the pixels be image stable, so that the state of eachpixel can be maintained without a constant supply of power.

oElectronic paper was developed in order to overcome some of the limitations of computerimonitors. For example, the backlighting of monitors is hard on the human eye, whereas electronicpaper reflects light just like normal paper. It is easier to read at an angle than flat screen monitors. It is lightweight, durable, and highly flexible compared to other display technologies, though it isnot as flexible as paper.

Predicted future applications include e-paper books capable of storing digital versions of manybooks, with only one book displayed on the pages at any one time. It is a portable, reusable storage and display medium that looks like paper but can be repeatedly written on electronic means -thousands or millions of times.

tE paper consisted of two transparent layers containing oil with suspended beads. The beads have different colored hemispheres; charged positively and negatively. When a charge is applied to the sandwich, the beads rotate. Full rotation displays as black or white and a partial rotation displays in gray shades. The image stays until a new charge in applied.

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UABOUT LUCENT TECHNOLOGY

dThe company E-ink has developed electronic ink and e-ink displays withthe collaboration of Lucent Technologies.

Electronic ink is a proprietary material that is processed into a film for integration into oelectronic displays. Although revolutionary in concept, electronic ink is a straightforward fusion of nchemistry, physics and electronic to create this new material. The principal components of nelectronic ink are millions of tiny microcapsules, about the diameter of a human hair. In one incarnation, each microcapsule contains positively charged particles of white titanium dioxide and negatively charged black or blueliquid dye particle suspended in a clear solution that change color when exposed to an electric charge. That is the charged dye particles move either up or down within the capsules. When a negative charge is applied, the white particles move to the top of the ecapsule where they become visible to the user.

aThis makes the surface appear white at the spot. At the same time an opposite electric echarge pulls the black or blue dyeparticles to the bottom. But reversing the process, black/blue dye cparticles appear at the top of the capsule, which now makes the surface dark at that spot.

Once the image is formed no power is required to keep the particle in position. To form an E-ink electronic display, the ink is printed on to a sheet of plastic film that is laminated to a layer of circuitry. The circuitry forms a pattern of pixels that can then be controlled by a display driver. The display is made up of several layers and is approximately 1mm in thickness.

These microcapsules are suspended in a liquid "carrier medium" allowing them to be printed using existing screen-printing processes ink virtually any surface, including glass, plastic, fabric and even paper. Ultimately electronic ink will permit almost any surface to become a display, bringing information out of the confines of traditional devices and into the world around us.

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KEY BENEFITS

Unlike conventional LCD's and other kinds of reflective displays, an electronic ink display is exceptionally bright and is ready viewable under both bright and dim lighting conditions. To be more assertive we could compare electronic ink display with the latest liquid crystal displays.

Table 1: Comparison of E-ink & LCD

Electronic ink	Liquid Crystal Displays
display	Best image only from one
Wide viewing angle	position Gray on gray
Black on paper	Can be difficult to see
white	Required power to hold
Readable in sunlight	images Often requires
Holds image without power drain	backlight
Legible under most lighting	Glass only
conditions Plastic or glass	Power supply and glass make
Light Weight	LCDs relatively heavy
	Thick (~7 mm)
Thin (~1 mm)	

4.1 Paper-like Readability

Paper is easily readable over wide variations in lighting conditions and viewing angle. E Ink's electronic ink technology approaches printed paper in performance by incorporating the same coloring pigments often used to make paper white and ink black.

When reading text, both reflectance and contrast are important factors in determining the

readability of a display. In fact, the contrast of E Ink is nearly twice that of printed newspaper. As can be seen from its high reflectance and contrast the E Ink display is much more readable

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than LCD.

The bright paper-white background of electronic ink eliminates the need for a backlight is most conditions.

4.2 Ultra-Low Power Consumption

Electronic ink displays offer greatly reduced power consumption. Lower power consumption translates to longer battery life, and perhaps more importantly, the ability to use smaller batteries in electronic ink devices- reducing device weight and cost. The reason for the reduced power consumption offered by electronic ink displays is two-fold: (1) they are completely reflective requiring no backlight and (2) they are inherently bi-stable for extended periods of time. Once an image is written on an electronic ink display, it will be retained without additional power input until the next image is written. Hence the power consumption of an electronic ink display will ultimately depend upon the frequency at which the displayed image is changed. However, in both cases, a reduction in power consumption by several orders of magnitude can be achieved by using electronic ink with its bi-stable imaging.

4.3 Thin, Light Form Factor

An electronic ink display module is thinner, lighter weight, and more robust than conventional LCD's. These benefits are especially important in smart handheld applications where portability is paramount. First generation, electronic ink displays will be but by laminating electronic ink to a conventional glass TFT substrate In addition, no polarizes are required for electronic ink displays. The resulting electronic ink display cell is also about half that of a typical LCD cell. Elimination of the glass top sheet means that displays made with an electronic ink display module should be inherently more robust.

4.4 The Ultimate Mobile Display Solution

Paper-like viewing characteristics and appearance, combined with ultra-low power consumption and thin light form factors, make E ink's electronic ink display material the ideal technology solution for information intensive, handheld devices such as PDAs, mobile phones

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and electronic readers; or any applications requiring a high degree of display legibility.

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