E-Paper Technology

Anitta Joseph
Vth Semester B.Sc. Computer Science
Vimala College, Thrissur

Abstract: **Made of flexible material, requiring ultra-low power consumption, cheap to manufacture, and most importantly, easy and convenient to read, E-papers of the future are just around the corner, with the promise to hold libraries on a chip and replace most printed newspapers before the end of the next decade.Electronic paper(E-paper) is a portable. Reusable storage and display medium that looks like paper but can be repeatedly written on (refreshed) by electronic means, thousands or millions of times. E-paper will be used for applications such as e-books, electronics newspaper, portable signs, & foldable, rollable displays. Information to be displays is downloaded through a connection to a computer or a cell phone, or created with mechanical tools such as an electronic "pencil". This paper discusses the history, features, and technology of the electronic paper revolution. It also highlights the challenges facing E-paper and its various applications. The paper concludes that E-paper, which can be termed as the second paper revolution, is closer to changing the way we read, write and study; a revolution so phenomenal that some researchers see it as second only to the invention of the printing press by Gutenberg in the 15th century.**

Keywords: Electronic paper, E Ink, Invention, Printing, Innovation, Print Media

I. INTRODUCTION

Electronic paper, e-paper or electronic ink display is a display technology designed to mimic the appearance of ordinary ink on paper. Unlike a conventional flat panel display, which uses a backlight to illuminate its pixels, electronic paper reflects light like ordinary paper. It is capable of holding text and images indefinitely without drawing electricity, while allowing the image to be changed later. To build e-paper, several different technologies exist, some using plastic substrate and electronics so that the display is flexible. E-paper has the potential to be more comfortable to read than conventional display. This is due to the stable image, which does not need to be refreshed constantly, the wider viewing angle, and the fact that it reflects ambientlight rather than emitting its own light. An e-paper display can be read in direct sunlight without the image appearing to fade. The contrast ratio in available displays as of 2008 might be described as similar to that ofnewspaper, though newly-developed implementations are slightlybetter. There is ongoing competition among manufacturers to provide full-color capability. Applications include electronic pricing labels in retail shops, and general signage, time tables at bus stations, electronic billboards, the mobile phone MOTOROLA FONE F3, and e-Readers capable of displaying digital versions of books and e-paper magazines. Electronic paper was developed in order to overcome some of the limitations of computer monitors. These limitations include the backlighting of monitors which is hard on the human eye, while electronic paper reflects light just like normal paper. In addition, e-paper is easier to read at an angle than flat screen monitors. Electronic paper also has the potential to be flexible becauseit is made of plastic. It is also light and potentially inexpensive.

II. TECHNOLOGY BEHIND E_PAPER

The E-Paper is also called Electronic Paper or Electronic ink Display. The first E-Paper was developed in 1974's by Nicholas K Sheridon at Xerox's Palo Alto research centre. The first E-Paper is Gyricon, it is based on a thin sheet of flexible plastic containing a layer of tiny plastic beads each encapsulated in oil and it rotate freely. Gyricon consisted of polyethylene spheres between 75 and 106 micrometers across. Each sphere is a Janus particle composed of negatively charged black plastic on one side and positively charged white plastic on the other. An E-Paper has two different parts front plane and back plane. The front plane consists of E-Ink and backplane consist of electronic circuits. To form an E-ink electronic display the ink is printed onto a plastic film that is laminated to a layer of circuit. Other form of E-ink with improve properties compared to Gyricon is Electrophoretic. Electrophoresis is a process, which enables separating molecules according to their size and electrical charge by applying an electric current. In an electrophoretic front plane, small charges submicron particles are suspended in a dielectric fluid that is enclosed into a sub-pixel size cell or microcapsule. When an electric filed is applied across the cell or capsule, the ink particles will move towards the electrode with the opposite charge. With a transparent electrode, the cell or capsule takes in the color of the ink when current is applied. The contrast is improved by using opposite colored particles such as black and white- and charging them with opposite polarities.

When current is applied, all the black particles will migrate to one side, and all the white to the other. Switch the field, and the capsule will change color. This enables switching between all black particles and all White particles on the transparent front electrode of the cell or microcapsule. This is how the high contrast ratio of electrophoretic display is created.

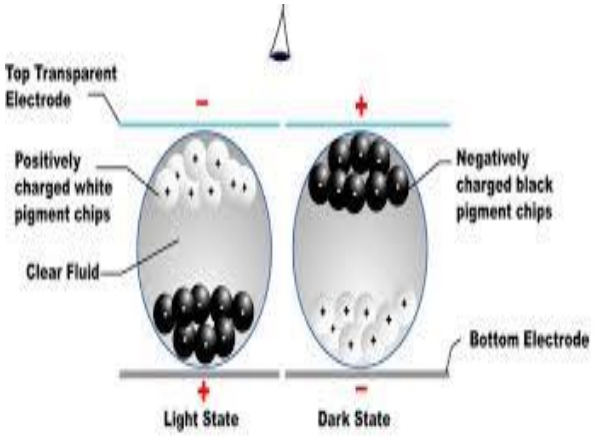

FIGURE 1. HIGH CONTRAST RATIO OF ELECTROPHORETIC DISPLAY

The electrophoretic technology used by E-ink is the most widely known and used form of E-paper. Known as electronic ink, it is a proprietary material that is made into a film for incorporation ink a paper-like display.

Another approach to the problem of low-power, high quality color in E-paper comes from the Novel devices lab at the University of Cincinnati. The technology, called electiofluidic display, uses voltage to manipulate colored ink in much the same way that print heads operate in color printers.

III. WORKING OF E-PAPER

E-paper comprises two different parts, the first is electronic ink, sometimes referred to as the 'frontplane', and the second is the electronics required to generate the pattern of text and images on the E-ink page, called the 'backplane'.

Over the years, a number of methods for creating e-ink has been developed. The Gyricon E-ink developed in the 70s by Nick Sheridon of Xerox is based on a thin sheet of flexible plastic containing a layer of tiny plastic beads, each encapsulated in a little pocket of oil and thus able to freely rotate within the plastic sheet. Each hemisphere of a bead has a different color and a different electrical charge. When an electric field is applied by the backbone, the beads rotate, creating a two colored pattern. This method of creating E-ink was dubbed Bichromal front plane.

Another such technology is electrophoretic front plane developed by the E-ink Corporation. Electrophoretic front plane consists of millions of tiny microcapsules, each approximately 100 microns in diameter (about as wide as a human hair). Each microcapsule is filled with a clear fluid containing positively charged white particles and negatively charged black particles. When a negative electric field is applied, the while particles move to the bottom of the capsule and are thus hidden from view. When a positive electric filed is applied, the black particles migrate to the top and the white particles move to the bottom generating black text or a picture. The brightness and resolution of electrophoretic based E-ink is better than that of bichromal-based E-ink, but both are monochromatic in nature. To create color, E-ink joined hands with the Japanese company Toppan printing which produces color filters.

IV. ADVANTAGES

Electronic Paper offers several advantages over printed paper. For example you can use electronic bookmarks, choose you preferred level of magnification, you can also use search to find information quickly, and you have the option to print on to real paper if required.

Advantages of electronic paper include low power usage (power is drawn when the display is updated), flexibility, and better readability than most displays. Electronic-ink can be printed in any surface, including walls, billboards, product labels, and T-shirts. The ink flexibility would also make it possible to develop roll-able displays for electronic devices.

V. DISADVANTAGES

A major disadvantage of electronic paper technology is very low refresh rate compared with other low-power display technologies like liquid crystal displays (LCDs). This prevents products from implementing sophisticated interactive applications (using fast moving menus, mouse pointers or scrolling) like those which are possible on handheld computers.

Piracy has become a huge source of problems for organizations in certain types of markets, such as music, movies, and games. With e-books, it could be easy for organizations to lose a lot of money from piracy.

The technology behind E-paper cannot support animation**.** With such a feature missing from e-paper, advertising is limited to pictures only, which is bad news for any organization that wishes to use animations in their ads with e-paper.

VI. APPLICATIONS

Electronic paper is the way out for people who read off the screen. The E-paper revolution will involve handheld displays of high contrast that are readable in direct sunlight, followed by low power–consuming book readers, then the electronic signs and billboards and expectedly the pocket document reader. Some notable applications of electronic paper include:

A.Education: Digital School Books

In January 2007, the Dutch specialist in E-paper, edupaper.nl started a pilot project in a secondary school in Maastricht, using E-paper as digital school books to reduce costs and students daily burden of book.

B.Wristwatches

In December 2005, Seiko released their Spectrum SVRDOOITM wristwatch which has a flexible elestrophoretic display and in March 2010, Seiko released a second generation of this famous E-ink watch with an active matrix display.

C. E-books

In late 2007, Amazon began producing and marketing the Amazon KindleTM, an E-book with an E-paper display. In February 2009, Amazon released the Kindle2TM and in May 2009, the larger Kindle DXTM was announced. In November 2009, Barnes and Noble launched the Barnes and Noble NookTM, based on the AndroidTM operating system. It differs from other big name readers in that it has a replaceable battery and a separate touch screen below the main reading screen.

D. Newspapers

In February 2006, the Flemish daily *De Tijd* distributed an electronic version of the paper to select subscribers in a limited marketing study, using a pre-release version of the iRexi.Lad. This was the first recorded application up electronic ink to newspaper publishing (Wikipedia, 2010).

E. Cell Phones

Motorola low-cost mobile phone, the Motorola F3TM uses an alphanumeric black/white electrophoretic display. The Samsung Alias2TM mobile phone incorporates electronic ink from E-ink into the keypad, which allows the keypad to change character sets and orientation while in different display modes.

F. Status Displays

Some devices, like USB flush drives have used electronic paper to display status information, such as available storage space.

VII. FURTHER SCOPE

The E-paper will be embedded as a cylindrical tube (about 1 centimeter in diameter or 15 to 20 centimeters long), that a person can comfortably carry in his or her pocket. The tube will contain a tightly rolled sheet of E-paper that can be spooled out of a slit in the tube as a flat sheet, for reading, and stored again at the touch of a button.

Information will be downloaded (there will be a simple user interface) from an overhead satellite, a cell phone network, or an internal memory chip. The document reader will be used for E-mail, the internet, books download from a digital library, technical manuals newspapers, magazines etc. anywhere in the planet. It will cost quite less than $10, and nearly everyone will have one. The surest way to produce the future of E-paper to invent it. E-paper is rich in potential.

Judging by recent developments in terms of display size and power consumption in E-readers coming to market, the future of E-paper technology is bright. In 10 to 20 years, consumers might see large E-paper modules that are as thin and as flexible as magazines are today, with display brightness approaching that of conventional print. In Heikenfeld's imagined future, these solar-powered devices will have touch interfaces, communication capabilities, and be so energy efficient that changing them will be an afterthought. You might click on an image in a story, and it will provide video or animation.

VIII. CONCLUSION

Today, paper remains the most popular document medium because of its credibility, tangibility, ease of use, flexibility, portability, and compatibility which has made it difficult to replace. Even with the prevalence of computers and online documents, the paperless office is more distant than when it was proposed. With paper a document flowing at a faster pace than ever, the need for more document management system becomes increasingly inevitable. Sheridon believes that E-paper will eventually be able to make power hungry desktop displays obsolete and help make heavy back-breaking textbooks something school children might learn about in a history class on their lightweight E-readers. Though new technologies are misperceived as total replacements for old ones, when in fact, the introduction of a new technology can simulate a synergy between old and new, we should reconsider the argument to completely replace all paper documents with electronic documents, and consequently, we predict a co-existence between paper and E-paper.

REFERENCES

[1] http://www.akamaiuniversity.us/PJST.htm
[2] https://en.wikipedia.org/wiki/Electronic_paper
[3] http://www.slideshare.net/PRADEEPCHEEKATLA/e-paper-18053302
[4] http://www.webopedia.com/TERM/E/electronic_paper.html
[5] http://www.computerworld.com/article/2535080/computer-hardware/the-future-of-e-paper--the-kindle-is-only-the-beginning.html.
[6] Liu, Z and D. Stork. 2000. "Is Paperless Really More? Rethinking the Role of Paper in the Digital Age". Communications of the ACM. 43(11).Nov. 2000.