

ELECTRONIC PAPER TECHNOLOGY

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ABSTRACT

E-Paper or electronic paper or electronic ink is a revolutionary material that is made with the promise to hold libraries on a single chip. It is light weight, glare free, low-cost, flexible, and having ultralow power consumption. It looks like ordinary paper but can be written repeatedly one thousands of time. This paper describes the history, features and technology used in e-paper. This also includes its advantages and disadvantages and its various applications. Thirty-five years in the making of electronic paper is now closer to modify the technique we read, write and study. E-papers of the future are just around the corner to replace most printed newspapers before the end of next decade.

I INTRODUCTION

In 1970s, the first electronic paper was developed at Xerox's Palo Alto Research centre by Nick Sheridan. Gyricon was the first electronic paper, consisted of small, statically charged balls that were white on one side and black on the other. The text was altered by the presence of an electric field, causes the balls up or down. Joseph Jacobson was developed another type of electronic paper in 1990s, who soon after co-founded the corporation E Ink which formed a business with Philips Components.

After two years, two companies are carrying works in the field of development of electronic ink. One is E-ink a company at Cambridge, U.S.A. Second is Xerox doing research effort at Xerox's Palo Alto Research Centre?

To build e-paper several different technologies exist, some using plastic substrate and electronic so that the display is flexible. E-paper technology is designed to mimic the appearance of ordinary ink on paper. E-paper reflects light like an ordinary paper and holds and images without drawing electricity, while allowing the image to be change later .An ideal e-paper display can be read directly in sunlight without the image appearing to be fade.

II TECHNOLOGY USED

2.1 Gyricon

Gyricon was the first e-paper developed in 1970s at Xerox's Palo Alto Research Centre. It is composed of polyethylene spheres of about 75 to 106 micrometers across. Each sphere (Janus particle) is composed of black plastic on one side and white plastic on the other which is negatively and positively charged respectively. In a

transparent silicone sheet these spheres are embedded, with each sphere dispersed in a bubble of oil so that every sphere can spin freely. The applied voltage polarity to each pair of electrodes determines whether the black or white side is face-up, hence giving the pixel a white or black look. Using this technology, Japanese company Soken has established a wall with electronic wall-paper at the FPD 2008 exhibition.

2.2 Electrophoretic display

These displays form visible images, by rearrange charged colored particles using an applied electric field. In this display, titanium dioxide particles are detached in hydrocarbon oil to which a dark colored dye is added with surfactants and charging agents and then this mixture is placed between two parallel conducting plates. When an electric field is applied to it, the particles will move towards the plate bearing opposite charge. If these particles accumulate at the front side of the display it looks white as light is reflected back by titanium particles and if these are located at the back side then it appears black because incident light is absorbed by colored dye. By applying suitable voltage to each area of the display to generate a pattern of reflecting and absorbing regions, resulting in the configuration of image in these displays. The electrophoretic technology used by E-ink is the most commonly known and used form of E-paper.

2.3. Electrowetting

In this technology, the shape of water/oil interface is controlled by applying appropriate voltage. The interfacial tension between coating and the water, changes when voltage is applied between electrode and the water resulting in a stacked state. This state is no more stable causing the water to move the oil to one side and results in a partially transparent pixel, or in a white pixel, if a reflective white plane is used. The observer only experiences the average reflection due to the small size of pixels and this reflection forms the basis of reflective display.

When no voltage is applied, between the water and a hydrophobic insulate covering of an electrode, the oil forms a flat film, resulting in a coloured pixel.

Electrowetting displays have several attractive features. These displays consume low voltage and low power and can be made thin and flat. The switching between white and coloured reflection is fast enough to show video content.

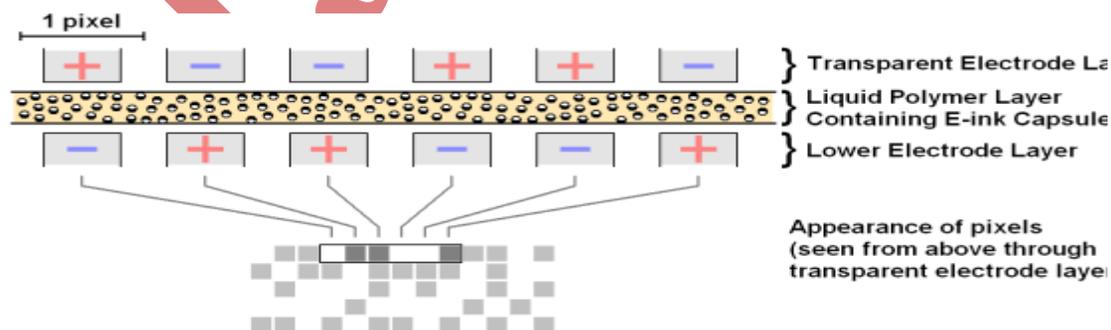


Fig-1: Appearance of pixels seen from transparent electrode layer

2.4. Electro fluid

These displays are a variation of an electro wetting display. In these displays inside a small reservoir aqueous pigment dispersion is placed. The reservoir comprises <5-10% of the viewable pixel region and thus the pigment is significantly hidden from view. When voltage is applied the pigment is electromechanically dragged out of the reservoir and spread like a film directly behind the viewing substrate. As a consequence, the display takes on color and brightness alike to that of conventional pigments written on paper. When voltage is removed liquid surface tension causes the pigment dispersion to quickly withdraw into the reservoir.

The core technology was invented at the Novel Devices Laboratory at the University of Cincinnati. Gamma Dynamics currently commercialized this technology.

III ADVANTAGES AND DISADVANTAGES OF E-PAPER

E-Paper has numerous advantages over ordinary paper. It has paper like readability and can also be readable in presence of sunlight. E-paper has ultra low power consumption and thus having longer battery life. Since e-paper is made of using soft plastic containing small particles and fluid hence it is flexible and twistable like an ordinary paper and also thin and light weighted .E-Paper is not full colored yet and also not supports animations. Another limitation is that it has low refresh rate and has very slow zoom or a document cannot be efficiently zoomed.

Another limitation is that imprints of an image may be seen after refreshing parts of the screen. Those imprints are known as ghost images and the effect is known as ghosting. This problem is solved after the screen is refreshed several times.

IV APPLICATIONS OF E-PAPER

Electronic paper behaves similar to the conventional paper. Some examples of Electronic Paper applications are described below.

1. Electronic watch and clock

Electronic paper can be used to display time and images which enables watch and clock designs to be more innovative. Shown in Fig 1

2. E Books

In 2004, the first e-book reader (EBR-1000EP by SONY) with an electronic paper display is released . In November 2006, the iRex iLiad (e-book reader) was released .In late 2007, Amazon released the Amazon Kindle, an e-book reader with an e-paper display .

3. Smart Card Display

Today, many credit cards contain a smart card to hold information such as money expenses and accumulated credit etc. Shown in Fig 2



Fig 1



Fig 2

4. Newspaper

Since e-paper is light-weight, flexible, twistable and consumes ultra low power so most of the newspaper agencies also use e-paper to publish the news. Eg-The Times of India, Hindustan Times, The Indian Express and many others.

5. Other Products

Clothes, digital photo frames, information boards and keyboards are the other proposed applications of e-paper. Applications like video editing or games and for less represented languages use keyboards with dynamically changeable keys.

V FUTURE OF E-PAPER

The purpose of electronic paper is not to diminish or to eliminate the conventional displays but it is to exist together with traditional paper and other display technologies. In the coming years, electronic paper may have a everlasting impact on the publishing industry. It is now a dominant product in the market and one day, electronic paper will realize the dream vision of paperless office.

VI CONCLUSION

Electronic Paper Display technology has been a long time coming. The idea of E-paper, a display that looks and works like an ordinary paper, has been developed a long time ago and has become very popular now a days. E-paper would hold its contents without consuming power and is readable in presence of sunlight. The content could be erased and rewritten one thousand of times. Today's EPDs and today's e-book readers are only the beginning and it will prove to be a good replacement of ordinary paper.

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