

Development of E-paper Technology

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Abstract:

This technology requires ultra-low power consumption and is made up of a flexible material, It is cost effective to manufacture, and further more it is suitable and easy to read. With the break through in its hardware, E-papers might be just around the corner faster than we know it, with the advantage to hold huge amount of data on a single chip and overcome the decades old and convenient printed newspapers. Electronic paper is generally referred to as E-paper, It is easy to carry around, can be reused to store data and is a display medium that gives the simulation of a paper but can repeatedly display different content on it with the help of electronic means, Multiple times using the same E-paper. E-paper in the future can be used instead of books, newspaper, signs and displays, unlike the the current displays. Information to be displayed can generally be downloaded through the help of a computer or a cell phone, or can be done using a electronic device such as electronic “pencil”. This paper talks about how the technology has come about over the years and its uses and its evolution. It also showcases the difficulties that are faced by E-paper and its various applications. The paper finishes on the note that Electronic paper or E-ink, which can be coined as the second paper revolution and with the new and improved technologies and ideas we are much more closer to changing the way we have always read, wrote and studied. It is a revolutionary technology so fantastic that some researchers see it as the next best thing to Gutenberg invention of printing press in the 15th century.

Keywords: Electronic paper, E paper, E Ink-display, Future display technology, Printing Innovation, Print Media device.

I. INTRODUCTION

E paper technology is made keeping in mind, to give the look and feel of an ordinary paper. When compared to other displays which are usually flat panels, electronic paper reflects light which gives a visual experience of and feel of reading of from a normal paper. Once the content is displayed it can hold text and images until moving on to the next without taking up any electricity. There exist several different technologies to build e-paper, Flexibility is reached by making use of plastic materials and supporting electronics.

Since E-paper is very comfortable to read compared to other displays present in the market, this gives it a unique potential value. This is due to the fact that it provides stable images, which aren't needed to be refreshed constantly like the other displays like LCD's and LED's, also providing a better and a wider viewing angle, and also the fact that it give off ambient light rather than showcasing its own light which is great in terms of power consumption and at the same time comforting to the reader's eyes. Unlike others E-paper displays the image does not appear to be faded or hard to read under the direct sunlight. When talked about contrast ratio they appear to be

similar to the newspaper as of 2008 and getting even better with the every new development phase its going through.

The amount of competition is gradually increasing to provide e-paper with full color capabilities. So examples of such is the electronic pricing labels in retail shops, and general signage, time schedules of the buses at bus stations, electronic billboards, the mobile phone like the Motorola's phone F3, and E-Readers such as Amazon's Kindle produced and market in 2007 which is able to display digital versions of books and magazines. Electronic paper was developed keeping in mind the fall backs of computer monitors in the current date and age .

II. TECHNOLOGY BEHIND E-PAPER

The E-Paper stands for Electronic Paper or Electronic ink Display. Nicholas K Sheridan was the first person to develop E-paper in the 1974 at Xerox's PARC. The first E-Paper know to man is the Gyricon, Which is based on a thin sheet of flexible plastic containing a layer of tiny plastic beads which was each encapsulated in oil and it rotated freely. E-Paper is made up of two different parts first being the front plane and second being the back plane. The backplane consist of electronic circuits and the front plane consists of E-Ink. The ink is printed onto a plastic film that is placed on to a layer of circuit, the E-ink electronic display is formed. The improved version of Gyricon is the Electrophoresis.

Electrophoresis is a process in which, when electrical current is applied the molecules separate according to their size and electrical charge.

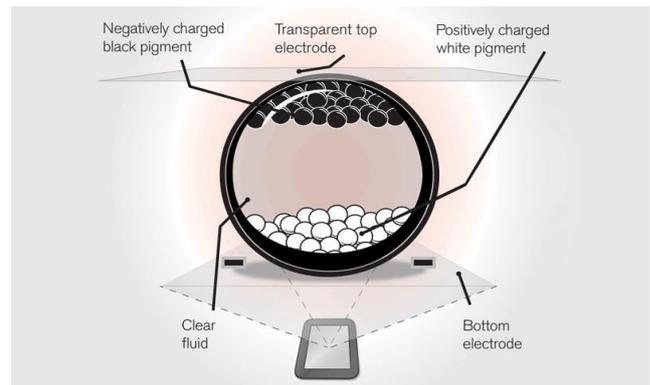


FIGURE 1 - HIGH CONTRASTION OF ELECTROPHORETIC DISPLAY.

The most well known and applied form of E-paper technology is the electrophoretic. Known as electronic ink, it is a material that can hold the ink that is made into a film, To show the paper look alike display.

Novel devices lab at the University of Cincinnati came up with the possible solution to the problem of low-power, high quality color in E-paper called electrofluidic display, it makes use of voltage to manipulate colored ink similar to that of color printers.

III. WORKING OF E-PAPER

E-paper is made up of two parts, the first being the electronic ink which is generally referred to as the "front plane", and the second is the hardware component's which prints the patterns of text and images on the E-ink page which is know as the "backplane".

Looking at E-ink we can see that over the years there have been various ways of creating it. Among all the E-ink technologies the most noticeable is the Gyricon. It was developed by Nick Sheridan of Xerox in the 70s, Gyricon is made up of slim plastic material which is mostly flexible and which contains tiny plastic beads, every bead holds a tiny sphere containing oil and the tiny sphere containing

the oil is able to move around within the bead without any restriction.

The bead is spread into sections which can hold a different color and a different electrical charge. If there is an electrical charge given to the front panel via its back, the beads showcase a two-colored pattern, which generally is black for the text and white for the background. This is known as Bichromal front plane.

E-ink Corporation developed another such technology called the electrophoretic front plane. Electrophoretic front planes are made up of thousands of tiny micro-capsules, which is about a single strand of human hair. The micro-capsules hold clear fluid within them, which have two types of charge particles, firstly the positively charged white particles and secondly the negatively charged black particles. To create a textual representation, firstly a positive charge is applied to set the background and then a negative charge is applied to showcase the black particles on the top, which will then display the text or picture.

When talking about brightness or resolution of electrophoretic. It is better than that of bichromal-based E-ink, but when it comes to their nature they are both monochromatic. In order to create color, E-ink partnered up with Toppan printing, which is a Japanese based company which is known for producing color filters.

IV. ADVANTAGES

Electronic Paper provides many advantages when compared to printed paper. For example you can use multiple bookmarks as you wish, choose your level of magnification comfortable to your eyes. By using search you can find information quickly, you can print the information on a paper if needed. Advantages of E-paper include low power consumption, flexibility, better readability than most displays and comforting the reader's eyes. Electronic-ink

can easily be displayed on most surfaces like walls, billboards, product labels, corporate business cards and T-shirts. Development of roll-able displays for electronic devices is possible due to its ink flexibility.

V. DISADVANTAGES

When we talk about disadvantages, the one that is quite evident is the low refresh rate, which is not on par when we compare it to other displays like liquid crystal displays. Its costlier when compared to LCD's and other similar size displays, currently due to the lack of its presence in the main stream and production sector and lack a variety in font styles.

With internet becoming a tool necessary for day to day life which makes things easier and faster but it also comes with privacy concerns and piracy issues, which is a huge source of problem in terms of E-ink because since many organizations use E-ink for specifically showcasing certain type of media, such as music, movies and games etc. When we talk about e-books and specifically piracy issue, if not rightly taken care of, this can cause organizations in losing huge amounts of money. Even with the current advancements or upgrades in E-paper technology, E-paper still cannot support stable animation which can be used in corporate for business purposes. Which is one of the drawbacks of E-paper and also the cause of lack of investment and interest by such companies, which can take the E-paper onto a whole new level.

VI. APPLICATIONS

People who have to read from screens but do not want to strain their eyes, electronic paper or E-paper help them do it without straining the eyes. The E-paper in the future will have high contrast displays that can be easily handheld and will be very comfortable to read

even in direct sunlight, having low power consumption with the possibility of electronic signs and billboards.

It can be even as small as a pocket document reader. Some note worthy applications of electronic paper include:

A. Education:

The Dutch specialist in E-paper, edupaper.nl in Maastricht in January 2007 started its pilot project in a secondary school, which aimed at reducing the costs and students daily burden of books by making using of E-paper as digital school books.

B. Wristwatches:

Seiko released its first ever E-ink wristwatch Spectrum SVRDOOITM in December 2005, this had a flexible electrophoretic display and in march of 2010, another active matrix display E-ink watch was released by Seiko .

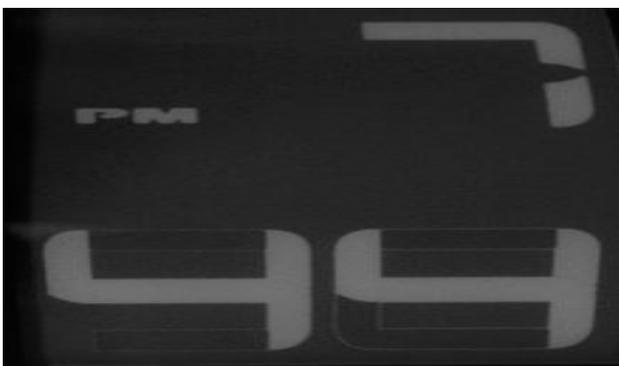


FIGURE2 - AN E-PAPER DIAPLY WATCH REFRESHES TO REMOVE GHOSTS.

Hybrid HR was launched by Fossil in 2019 this showcased a watch which had an E-ink display which was always on and was designed in such a way that it looked similar to that of an analog watch.

C. Status Displays:

E-paper has been used to display status information in USB flash drives, such as available storage space.



FIGURE3 - A USB PENDRIVE SHOWING THE AVAILABLE STORAGE SPACE USING AN E-INK DISPLAY.

D. Cell Phones:

Motorola used an E-paper display instead of an LCD which is an alphanumeric black/white electrophoretic display for its low-cost mobile phone segment, which is the Motorola F3TM. Samsung launched the Alias2TM which incorporated the E-ink into its keypad, By doing this the keypad could change character sets in different display modes.



FIGURE4 - E-PAPER DISPLAY USED INSTEAD OF AN LCD IN MOTOROLA F3.

"YotaPhone" a prototype version by Yota Devices was announced on December 12, 2012, The next was a very unique double-display smartphone by Yota Devices in December 2013, In this dual display version the front was a 4.3 inch full HD LCD display and at the back it had a E-ink display.

E. Public transport timetables:

Bus or trams stops have E-paper displays that can be remotely updated. E-paper consumes low energy when compared with LED or LCDs, which helps in cost cutting and maintaining text or graphics even if there is a power failure. It is clearly visible even under direct sunlight when compared to LCDs.



FIGURES - E-PAPER PROTOTYPE OF TRAP TIMETABLES IN PRAGUE, FROM MAY 2009.

F. Electronic Tags:

Integration of E-ink technology with E-paper electronic Tags is done wireless using interfaces like NFC or UHF. The most common use of E-paper in electronic tags is for tracking changes in the manufacturing section and for employee's ID status and also used as production labels. There has been an increasing use of E-Paper Tags in the shipping industry for shipping labels, specifically in reusable boxes. Some e-paper Tag manufacturers have come up with an interesting feature which is the batteryless design for its Tags.



FIGURE6 - LUMMICO E-PAPER IDS.

This means that the E-tags are battery less and power is supplied through wireless means for the displaying the updated content onto it.

VII. FURTHER SCOPE

According to the evolution of E-paper, E-paper in future can be a device that is closely similar to that of the size of a regular pen, which will make is easier in terms of mobility and usability. This can be viewed as a look alike of that of a scroll and similar to the scroll the E-paper is wrapped around a cylindrical tube which when rolled out the e-paper is seen and a touch button is available on the tube to view the content on the e-paper and when done you can touch the button back to switch it off and roll back the e-paper to carry it around in the tiny space of your pocket. The information to be display can be already be available in the chip which is inside the cylindrical tube or can be downloaded from a cell phone network or via satellite.

With the development and interest around e-paper, such as Amazon's kindle and with a little more upgrades to it or similar device. It can be used more commonly to read

e-books, emails, technical manuals, newspapers, magazines etc. With the help of internet all of these can be done from any part of the planet. If it is even used by half the people who read newspapers as of today, then its cost will go down drastically because of mass production and with newer methods for making it cheaper, which in term make it easily available to everyone. The best way to ensure the brightest future of E-paper is to invent and improve the hardware technology along the way. E-paper has rich potential for the future .

The more the companies and organizations get involved with e-paper the sooner the future of e-paper becomes a reality which intern making the future of e-paper even brighter than what we expect it to be. With the recent development in e-paper, we can expect the displays of the future to be super slim, having better resolution and have almost next to none power consumption making it a difficult for companies and organization not to be interested in it.

The future that Heikenfeld's envisioned, he talk about e-paper being solar powered, with touch interfaces, communication capabilities and would almost be impossible to think of an alternative to it. He also talked about how you could select an image for a story and a video or an animation, giving the backstory of the image would be shown.

VIII. CONCLUSION

Today, with technology growing faster than ever before, paper still is the best document medium available or known to man, it is due to its credibility, ease of use, flexibility, portability, and compatibility which has made it the product of the present and not the pat and making it extremely difficult to replace. Office spaces today have computers that can be considered not just fast but super fast to process anything and everything but even with this you cannot

imagine a complete setup of virtual documents for a given office space. Since the beginning of times i.e after the invention of paper, paper has remained the whole and sole king, in terms of document medium and with the current use of it, it doesn't look like its going to lose its place any time soon in the next decade or so. Sheridan believes that his invention the "E-paper", In future will make the power hungry displays a thing of the past and help change carrying of heavy school bags by children something one might learn in a history class on their lightweight E-readers. We for sure cannot say that future technologies like e-paper will completely wipe out the old one's like paper or if they will go hand in hand, only time will tell. But with paper having an adverse effect on the environment and the planet itself we can hope that its use might be kept at a minimum and technologies such as e-paper can and will try filling up those gaps.

REFERENCES

1. <http://www.akamaiuniversity.us/PJST.html>
2. https://en.wikipedia.org/wiki/Electronic_paper#References
3. <https://www.cnet.com/news/fossils-new-always-on-smartwatch-looks-like-a-smarter-pebble>
4. http://www.webopedia.com/TERM/E/electronic_paper.html
5. *Genuth, Iddo (2007-10-15). "The Future of Electronic Paper". *The Future Of Things*. Retrieved 2 March 2015.*
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.
7. <https://www.seminarstopics.com/seminar/7575/electronic-paper-seminar-report-pdf>