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Current Trends in Electronic Display Technology

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ABSTRACT

Owing to the increased demand and popularity of display screens, massive research and development has taken place in this field. A number of methods/techniques are being utilized in the manufacturing of the electronic display screens these days which differ from application to application. This paper briefly overviews various types of electronic displays that have been developed for electronic imaging.

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1) INTRODUCTION

Over the past decade, the Imaging technology has emerged as one of the most progressive and innovative technology. We have seen tremendous improvement in the available display options from the conventional CRT based devices to most modern LCD and Plasma displays (Sixti, 2003). This advancement has been the result of the continuous research and development in the field of electronic imaging. This is due to the fact that the display requirements for various applications differ from application to application considerably. The most familiar displays one encounters are the PC and of course, the television displays. Other display options include laptop computers, palmtop and wearable computers, head-mounted displays, wristwatch displays, and electronic projectors. Another area of real time image displaying is in the cockpit controls of modern commercial and fighter aircrafts. This article would explore the advancements made in modern display technology and the current trends in electronic display imaging. Refer to figure 2 to review the summary of existing display technologies.

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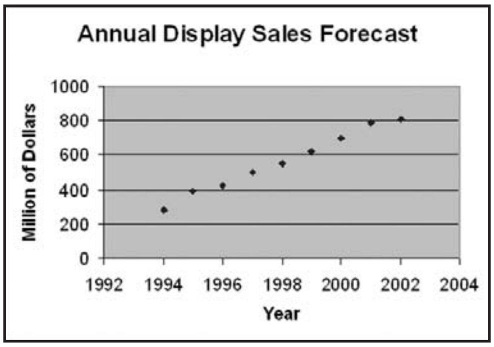
2) THE DISPLAY TECHNOLOGY ECONOMIC ASPECT:

Since the electronic display technology is one of the most rapidly growing technology, it has a very prosperous economic aspect also. (F.Khan, 1998)

Chart 1
Annual display sales forecast



As shown in the above graph, from 1993 to 2002 it shows a steady growth in the revenues in respect of the cameras and camcorders displays alone.

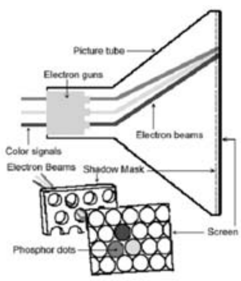
3) THE CONVENTIONAL CATHODE RAY TUBE (CRT)

The oldest yet the foremost example of electronic displays is of course the conventional Cathode Ray Tube (CRT) (GGP.Van, 1997). Here the intensity of the electron guns varies with respect to the picture information (the chroma and the luminance signals) and as a result of this variation the picture is reproduced on the phosphorous coated screen. Until recently, the number of picture elements (pixels) and the pixels' sequence and delivery rate (bandwidth) in color TV displays has remained constant; thus, pixel information capacity has not improved.(Paul, 1998)

TV displays, meanwhile, have become less expensive even as they have become larger. Their brightness and stability have also improved. This can be thought of as advancement in the manufacturing technology but it can not be called a technical innovation.

It's an accepted fact that many technological marvels in the electronic display technology

Figure 1
Cathode Ray Tube



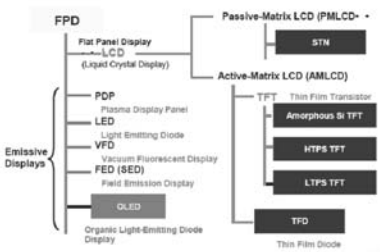
been encouraged the most by the computer industry as this industry is the lead consumer of electronic displays. Obviously a computer user would require a flicker, jitter and fuzz free display on which he can work for hours without the discomforting affects. Many computer users would also welcome the concept of auto-adjustment of the brightness, contrast and the colour in response to the existing lighting condition of the room or office where they are working. CRT displays these days is usually equipped with all this. CRTs continue as the dominant display technology and will for the foreseeable future, though their market share is slowly decreasing. Liabilities are CRT size, weight, power, and difficulty in achieving very high information content and highly resolvable pixel density. Refer to figure 1 for the working principle of CRT.

4) THE FIELD EMISSION DISPLAY (FED)

Field Emission Display (FED) is actually the basis of the Flat Panel Technology whose fundamental concept is the emission of electrons through field emitting cathodes bombarded on phosphorous coated screen which acts as a light emitting medium for display.

Instead of a single electron gun, a field emission display (FED) would use an array of fine metal

Figure 2
Flat Panel display technologies

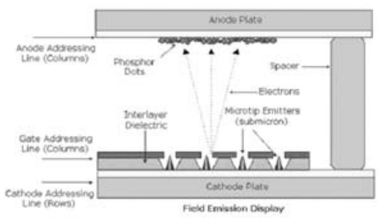


tips or carbon nanotubes (which are the most efficient electron emitters known) for emission of electrons (field emission), with many of them positioned behind each phosphor dot [9]. Working principle of FED is further elaborated in figure 3

The nanotube-based cathodes in this case are created using a process proprietary to Samsung in which combinations of multi and single-wall tubes are mixed into a photosensitive resin. The resin is then screen-printed onto the cathode backplane and photoexposed to define the cathode regions [10]. Samsung's device differs from most field-emission displays using so-called lateral field emitters. (Chhowalla, 2004)

This technology has the potential to overcome the effect of dead pixels even if approximately 20% emitters fail.

Figure 3
FED working principle



FED is energy efficient and belongs to that class of flat panel Screens which can consume even lesser power than LCD and plasma display technologies. They have pro-files similar to LCDs but do not require backlights.

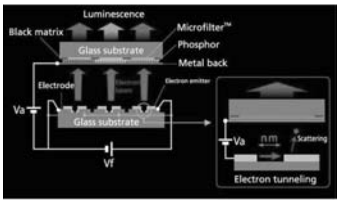
It is claimed that this technology is cost effective as fewer manufacturing processes are involved and the component count is comparatively lesser.

5) SURFACE CONDUCTION ELECTRON EMITTER DISPLAY (SED)

Surface Conduction Electron Emitter Technology is a variant of FED. Whereas FED uses a 'Spindt Tip (a Spindt tip is a tiny conical tip microfabricated on a substrate, which emits electrons by field emission. It is named after its inventor Charles A. Spindt) semi-conductor or carbon nanotube emitter, with multiple redundant emitters per area of display. An elaborated diagram of SED can be studied in Figure 4.

SED utilises a Palladium oxide based Emitter Array formulated by the inkjet or silk screen process. SED is a variant of FED. Uptill now no commercial SED display has been marketed. Motorola has given this technlogy the name Nano Emissive Display. A prototype model was displayed by Motorola in 2005

Figure 4
Simplified diagram of SED



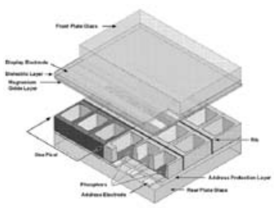
6) THE PLASMA DISPLAY TECHNOLOGY

Plasma is in fact highly energetic gaseous ions. The property of plasma is that it contains ions in approximately equal proportions i.e. the number of positively charged ions would almost be equal to negatively charged ions. But these ions would have very high energy levels. So as a whole, plasma is neutral from the electrostatic point of view but it would be having high energy content.

The base of the plasma display technology is the electro-optical generation through electrical discharge in a gas. The first attempts to make an electrical display method utilizing this effect dates back to 1954. Since then massive research has taken place in this field.

One of the prime advantages of this technology is that un-like other front view projection screens; one does not have to turn off the lights to see the display.

Figure 5
An Exploded View of a Single Plasma Pixel



The plasma display comprises of two glass plates separated by a small distance. The area between these glass plates is evacuated and filled with a gas mixture. The inside of one glass plate is quoted with phosphorous (in fact three types of phosphorous dot pixels in accordance with the three primary colours) layer. Voltage electrodes are placed inside the two glass plates to ionize the gasses for Plasma formation. When high voltage to these electrodes is applied, the gas is converted into plasma which hits the phosphorous screen to display colours. An exploded view of a single Plasma Pixel can be viewed in figure 5.

Plasma suffers from the only disadvantage that its power consumption is higher (http://dictionary.zdnet.com/definition/plasma+display.html). Power consumption for a 42-in. display can range from 350 to 700 watts. Technically Plasma displays are not suitable for very high resolution displays also. That is the reason why there use has been limited to Television displays of about 50 inches diameter.

7) THE LIQUID CRYSTAL DISPLAY (LCD)

Active-matrix LCD technology is the most preferred technology for the laptop computers. Typically called TFT/LCD (for thin-film transistor/liquid crystal display), this technology is currently making significant inroads in the desktop computer monitor market, with key manufacturers in Japan and Korea (B.Bahadur, 1990). Acombination of active matrix technology and Licquid Crystal display is expected to be the future of the compact, low power and efficient display technology.

Typical applications include micro displays, hand-held PDAs, laptop and desktop computer monitors, very high information content and high spatial resolution displays, and large-screen projection displays

Liquid Crystal Displays belong to the passive type displays. It means that they do not emit light themselves yet they use the ambient light in the surroundings. By using this light they display the images with very little power consumption. Due to this LCD has been the ultimate choice for low power, compact size displays.

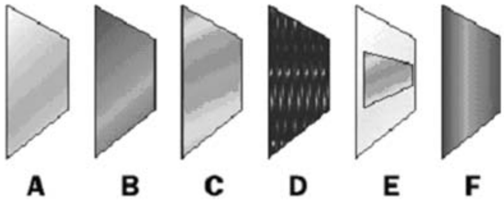
Liquid Crystal is organic in nature and possess both liquid and a crystalline molecular structure. In the crystal the rod shaped molecules are found in sort of a parallel array. The molecules can be controlled using the electrical stress (field). Currently most LCD use liquid crystal called 'Twisted Nematic (TN)'.

A fundamental LCD can be created using two pieces of Polarized Glass. A special polymer that creates microscopic grooves in the surface is rubbed on the side of the glass that does not have the polarizing film on it. The grooves must be in the same direction as the polarizing film. You then add a coating of nematic liquid crystals to one of the filters. The grooves will cause the first layer of molecules to align with the filter's orientation. Then add the second piece of glass with the polarizing film at a right angle to the first piece. Each successive layer of TN molecules will gradually twist until the uppermost layer is at a 90-degree angle to the bottom, matching the polarized glass filters. As light strikes the first filter, it is polarized. The molecules in each layer then guide the light they receive to the next layer. As the light passes through the liquid crystal layers, the molecules also change the light's plane of vibration to match their own angle. When the light reaches the far side of the liquid crystal substance, it vibrates at the same angle as the final layer of molecules. If the final layer is matched up with the second polarized glass filter, then the light will pass through.

If we apply an electric charge to liquid crystal molecules, they untwist. When they straighten out, they change the angle of the light passing through them so that it no longer matches the angle of the top polarizing filter. Consequently, no light can pass through that area of the LCD, which makes that area darker than the surrounding areas.

Building a simple LCD is easier than you think. Your start with the sandwich of glass and liquid crystals described above and add two transparent electrodes to it. For example, imagine that you want to create the simplest possible LCD with just a single rectangular electrode on it. The layers would look like this:

Figure 6
LCD working



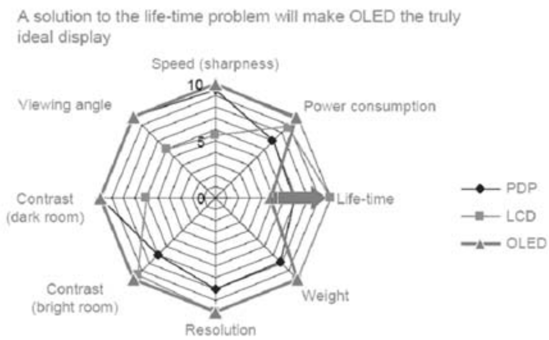
The LCD needed to do this job is very basic. It has a mirror (A) in back, which makes it reflective. A piece of glass (B) is then added with a polarizing film on the bottom side, and a common electrode plane (C) made of indium-tin oxide on top. A common electrode plane covers the entire area of the LCD. Above that is the layer of liquid crystal substance (D). Next comes another piece of glass (E) with an electrode in the shape of the rectangle on the bottom and, on top, another polarizing film (F), at a right angle to the first one. Figure 6 explains this concept clearly.

The electrode is connected to the power source which can be a battery. When there is no current ,the light entering through the front of the LCD will simply hit the mirror and would be reflected back. But when the battery supplies current to the electrodes, the liquid crystals between the common-plane electrode and the electrode shaped like a rectangle untwist and block the light in that region from passing through. That makes the LCD show the rectangle as a black area.

8) THE ORGANIC LIGHT EMITTING DIODES (OLEDS)

Since man first discovered fire, his use of controllable light was based on sources of heat, whose high temperatures meant that they emitted a small proportion of their energy as light. Fire was tamed to candle power, and electricity was harnessed to produce light from incandescent light bulbs. In the last couple of decades, solid state lighting in the form of light emitting diodes (LEDs) has become available, and these could be regarded as 'true' lighting devices.http://en.wikipedia.org/wiki/Thin_film_transistor_liquid_crystal_displa

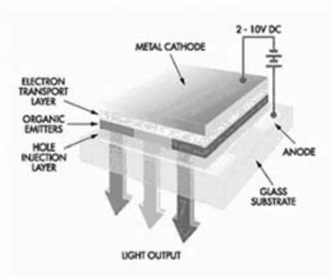
LCD vs. PDP vs. OLED



Less well known is the organic version of LEDs:OLEDs which in many ways are complementary to LEDs, and share their ability to be applied to commercial lighting applications The total market for solid state lighting has been forecast to reach $5.6 billion by 2008, with the key applications being in cell phones, signage and automotive sectors.

OLEDs come in two forms: those based on 'small molecules' and those which use polymers. The latter have the important advantage that they can be processed in solution, so opening up the possibility of manufacture using ink jet printing for instance. The leading company developing polymer OLED (P-OLED) technology is Cambridge Display Technology (CDT), and licensing its IP to companies such as Philips and Osram.

Figure 7
OLED working principle



OLEDs are regarded by many as the next generation of lighting and display technology, but it is the display market which tends to get more publicity. OLEDs are capable of high resolution pixel patterning, producing high contrast displays of good color gamut, extremely wide viewing angle and low power consumption. OLED working principle can be observed in figure 7. Their rapid response - at least a thousand times faster than liquid crystal displays (LCDs) - is a major factor in their likely replacement of LCDs in applications such as television and cell phones. Review chart 2 for a simple comparison between the two technologies.

The lighting market shares many of the requirements of the display market, but with different weightings and some unique features. Let's look at some of the characteristics of OLEDs and how they relate to lighting applications.

9) CONCLUSION:

Various formats of Electronic Displays have been discussed. Comparisons of some of the technologies have also been carried out highlighting the advantages and disadvantages. A number of them have successfully been fabricated and are commercially available as products. A few have initially being investigated and to date not commercially produced. The future would belong to compact energy efficient displays that can be fabricated cost effectively.

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