

A Review- on Different Types of Displays

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Abstract

Display technology has evolved much lately. No wonder the quality of a device is best judged by its display. In today's time, displays have gone from miniature monochrome screens on huge devices to thinner screens on smartphones and from monochrome to millions of colors and from no touch to multi touch support. But the most important point to be pondered upon is that a new type of display technology is now being actively adopted with the first devices with flexible screens to be launched in the near future. But before making a leap into that future of new technology, one must know how the display technology evolved and where it stands now. Discussing the various types of displays and their pros and cons, the paper depicts the switching of technology from one to another.

Keywords: Cathode Ray Tube (CRT), LCD, LED, OLED

1. Introduction

A display is a mechanism of projecting an output to the user which can either be text, numbers or graphic images. A device which produces colored light on the screen by using conversion of electric signals from a system is known as a monitor or display device. Along with the projection device, what basically constitutes a display is the screen or the device where output has to be displayed. Without a second thought, it is well known that a device is highly judged by the display it projects. Large number of displays each with a different projection mechanism has come up recently and is still continuously evolving [1]. Monitors have gone from monochrome that is black and white to millions of colors and from huge devices to thinner screens. This paper is an attempt to look into the history of display technology and where it stands now.

Figure 1 shows that the characterization of display devices as under: color capability, picture sharpness, viewing angles, the size of display screen and the projection technology. Color capability means how the color quality is projected on a particular device. Viewing angle gives the angular limit at which the projections can be observed precisely. Size of the screen varies for each display.

In this paper, displays have been characterized according to the projection technology. Since each device has its own pros and cons, a new technology that is replacing it is further discussed.

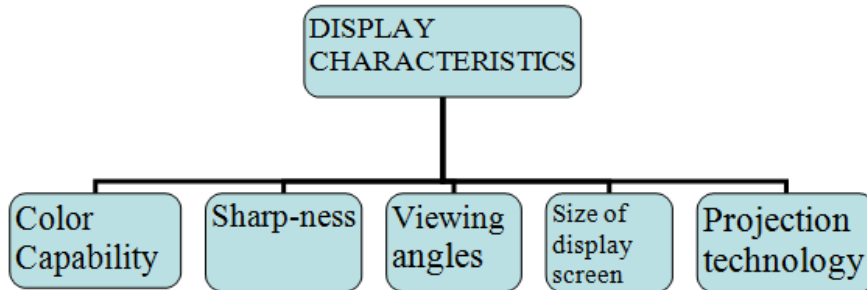


Figure 1. Characteristics of a Display Device

2. Types of Displays

Figure 2 shows the various displays covered here namely, the cathode ray tube (CRT), liquid crystal display (LCD), light emitting diodes (LEDs), Organic LEDs (OLEDs).

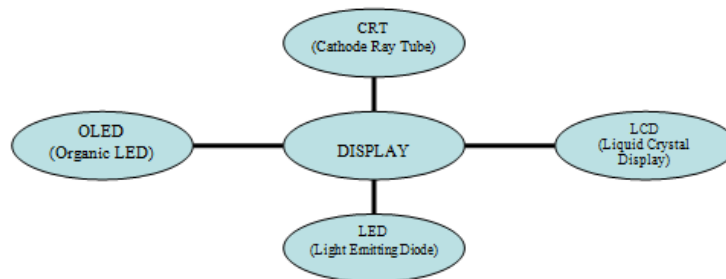


Figure 2. Types of Display Devices

A. Cathode ray tube(CRT) monitors

- The first display monitors to come into use have been the Cathode Ray Tube monitors. A monochrome CRT basically consists of four basic parts:

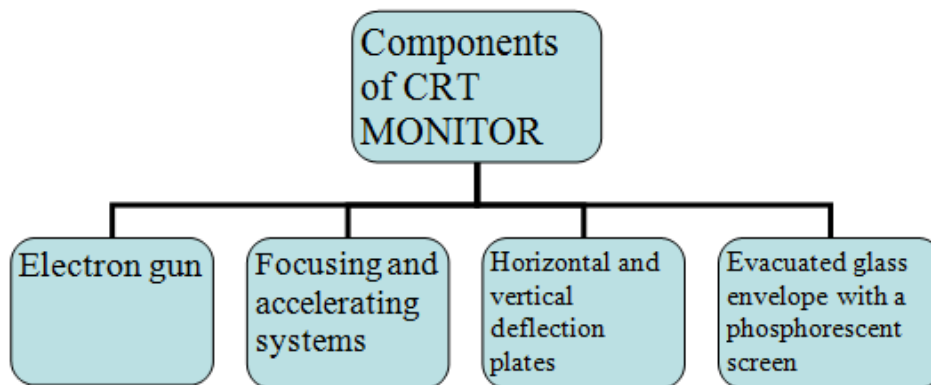


Figure 3. Various Components of a CRT Monitor

- Electron gun produces an electron stream, accelerating systems produce sharply focused beam, deflection plates control beam path, and the phosphorescent screen gives bright spot when the beam strikes it [2].

- Working of a coloured CRT monitor is very similar to a monochrome CRT, the only difference being that it has three electron guns that is three electron beams that are separately controllable.
 - The use of CRT monitors is decreasing day by day, reasons being that CRT technology requires a minimum certain distance from the beam projection device to the screen in order to function properly. Thus, it has a big back, making it heavy and takes up a lot of space.
 - Also, considering safety, CRTs emit X-ray band radiations in small amount which can result in a health hazard. Also the strong vacuum existing in it can also result in a implosion.
 - Thus, CRTs have largely been replaced by newer display technologies such as LCD, LED and OLED, which have lower manufacturing costs, power consumption, weight and bulk.
- B. Liquid Crystal Display (LCD)
- The era of flat panel displays started with the LCD. It uses a fluorescent light source and two polarizing filters [3].
 - Light is passed through first polarizing filters. This light is then passed through an array of liquid crystals pixels.
 - The crystal molecule is twisted by the electric field, which lights up the line with the second polarizing filter, thus lighting up the screen [4].
 - Although better than CRT in terms of flat screen, light weight and power consumptions, these LCDs are costlier and a limited viewing angle[5]. Also some of the pixels will die after some time and a discoloured spot is observed on the display.
 - The problem of discoloured spots was hugely removed by the construction of the LEDs.
- C. Light Emitting Diode (LED)
- These are very much similar to the LCDs in construction, except that the fluorescent source has been replaced by an array of light emitting diodes [6].
 - The LED backlighting can be done in two ways: Full- or Direct-Lit LED TV which has LED lights arranged behind the entire back panel and Edge-Lit LED TV which has a series of LED backlights running along the edges of the back screen, dispersing the entire screen by light guides.
 - LEDs, no doubt have been a better technology than the LCDs. The LED monitor produces more realistic colors than the CFL-lit LCD monitor.
 - Also, color fading is not an issue and they have long lives. These are by far the most power efficient display device. The only constraints being high cost and poor off viewing angle.
- D. Organic Light Emitting Diode(OLED)
- The organic light-emitting diodes (OLEDs) are a great source of producing highly efficient large-area light sources. An OLED produces light from electrical energy. Presently, the power efficiency of OLEDs is not as required. With continuous efforts, high power efficiencies are being obtained [7]. Further, with the creation of OLEDs, devices that can generate light on their own can be developed. The structure of OLEDs consisting of 5 layers is shown in figure 4:
 - Substrate is the outer most layer and the material is either glass or plastic.
 - With the application of voltage, the charges start moving between the conductive and emissive layers which are composed of organic molecules, such as polyaniline and polyfluorene [8].
 - When an electron combines with a hole, a photon is created, giving off light [9].
 - The electrical power applied to the electrodes is transformed into light.

- Thus, an OLED produces light on its own. Other advantages include its wide viewing angle, better brightness and excellent power efficiency.

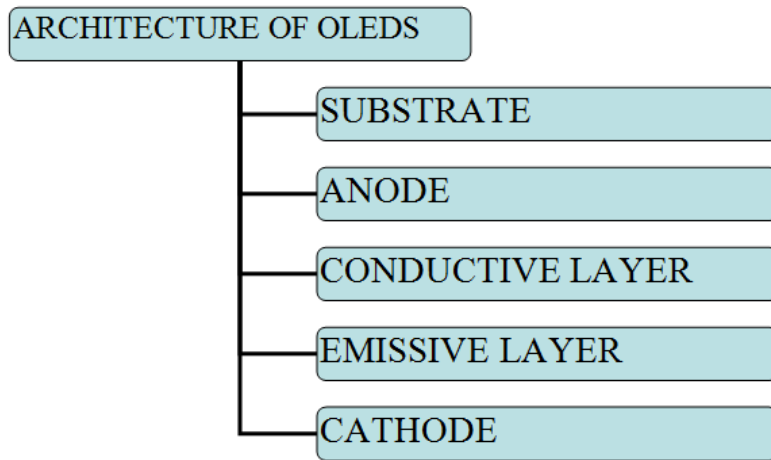


Figure 4. Layers of an OLED

3. Comparison

Table 1, Comparison Between Various Types of Displays

| <i>Parameters</i> | <i>CRT</i> | <i>LCD</i> | <i>LED</i> | <i>OLED</i> |
|-------------------|---------------|--------------------------|---------------------|-------------------|
| Technology | Vacuum tube | CFL backlight | LED array backlight | Produce own light |
| Color quality | good | Not as good as CRT | good | excellent |
| Black level | True black | Can't display true black | True black | True black |
| Power consumption | high | low | Very low | least |
| Contrast ratio | Over 15,000:1 | Over 1,000:1 | Over 10,000:1 | Over 1,000,000:1 |

| <i>Parameters</i> | <i>CRT</i> | <i>LCD</i> | <i>LED</i> | <i>OLED</i> |
|-------------------|----------------|-------------------|----------------|-----------------|
| Size | bulky | slim | slim | Very slim |
| Response time | negligible | $\geq 5\text{ms}$ | $< 5\text{ms}$ | negligible |
| Issues | Health hazards | Discolored spots | Price | Mass production |

The Table 1 gives the various parameters on which displays can be compared. As can be seen the color quality of CRT is better than the LCD, but other factors such as power consumption, size and weight have made LCDs more popular [10]. Although an LCD cannot display true black properly. Power consumed by a CRT is the maximum while an OLED consumes the least power. LEDs too are a better option than CRTs. Also, the table describes OLEDs as the best display unit in all the parameters of comparison.

4. Conclusion and Future Scope

From the comparison table one can conclude that the OLEDs are the best display technology by far. It provides excellent color quality and contrast ratio while consuming the least power.

With the development of new and better technologies day by day, efforts are being made to find a substitute for the high cost materials used in the LEDs and the OLEDs. Also, efforts are being done to increase the life span of the OLEDs by trying to use alternative substrates and a different material for the anode. Research is going on to test if a single crystal with sapphire substrates treated with gold film anodes can make a difference and increase its lifespan. In addition to this, various flexible devices are expected in the near future.

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