FLAT PANEL DISPLAYS FOR MEDICAL MONITORING SYSTEMS

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Abstract

Flat panel displays are ideal for demanding hospital and clinic applications like vital sign monitoring and bedside administration. They take up much less space than conventional monitors (CRT based) and can be wall-mounted, cart-mounted or used on a desk stand.

User friendly interface demands easy to use input device, rotary position encoders and touch screen panels offers simplicity replacing bulky keyboards.

This article will present an overview about today medical monitoring systems tendencies, describing as an example, a custom medical monitoring module developed to be integrated in an assisted ventilation system.

Keywords

Display, medical, monitoring, LCD, STN, TFT, EL, video, controller, encoder, touch, screen.

1. INTRODUCTION

The flat panel displays are finding a growing variety of applications in televisions, computer equipment, monitoring systems, etc. The expanding use of flat panel displays is the result of advances in graphics capabilities, color and size, and price reduction.

Cathode ray tube displays (CRTs) require high voltage to control electron beam and have a high size, so flat panel displays are the perfect substitute to CRTs in applications where more compact displays and low power requirements are demanded.

Until very recently, most devices used CRT monitors as their main display device because flat panel displays elevate cost. But today, prices are falling and the replacement process is quickly advancing.

Hospitals use flat panel displays to combine bedside monitoring and patient charting [9]. As an example we will describe a custom medical monitoring module developed to be integrated in an assisted ventilation system that uses an electroluminescent flat panel display.

We will present available flat panel displays technologies and get an overview about the two most used technologies: liquid crystal and electroluminescent displays. We will also take a look to interfacing flat panel displays in microprocessor systems, and present our medical monitoring system solution. Furthermore, we will present future line of work in medical monitoring enhancement: latest flat panel technologies available and improvements in input devices for user interface.

2. FLAT PANEL CLASSIFICATION

There are a large number of distinct flat panel displays that differ on the types of materials and the display method they use:

- Liquid crystal displays (LCD).
- Electroluminescent displays (EL).
- Plasma display (PDP).
- Vacuum fluorescent display (VFD).
- Field emission display (FED).

Among all these systems, the liquid crystal display and the electroluminescent display are considered to be the most promising. These two major technologies will be described in terms of working procedure and presented features.

2.1 LIQUID CRYSTAL DISPLAYS

Liquid crystal is a term that indicates the status of a substance that is neither solid nor liquid.

In natural state, the liquid crystal molecules are arranged in a loosely order with their long axes parallel. When coming into contact with a finely grooved surface the molecules line up parallel along grooves (figure 1).

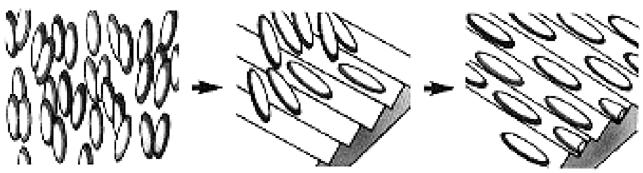

Figure 1: Liquid crystal molecule arrangement (Sharp technical library).

When two surfaces are sandwiched in 90º twist, they form a twisted liquid crystal molecule structural arrangement. When voltage is applied, molecules rearrange along with the electric field and light passes straight through along the structural arrangement of molecules.

Adding two polarizing filters to the twisted liquid crystal surfaces creates a liquid crystal display. In this case, when voltage is applied, the liquid crystal molecules rearrange and the light passes straight through along the structural arrangement of molecules. But the lower polarizing filter prevents light from passing (figure 2).

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Abstract

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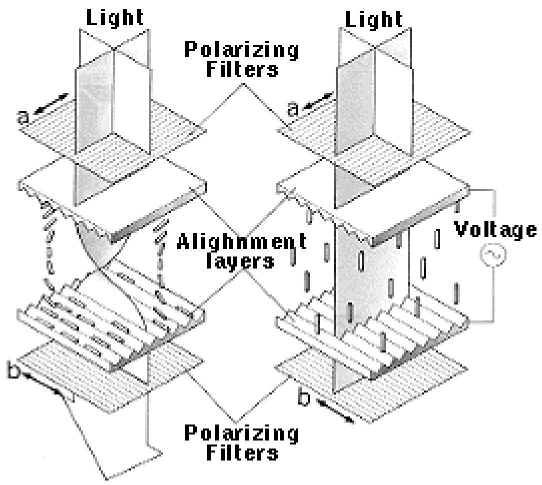

Figure 2: Blocking light with two polarizing filters (Sharp technical library).

LCD displays offer some advantages over CRT displays:

- High resolution.
- Lower display size.
- Lower power consumption.

And present some disadvantages:

- Low contrast.
- Slow response.
- Low viewing angle.

There are some enhancements in LCD technology than improve the basic features, solving disadvantages. In the historically LCD evolution (figure 3) we can find DSM (dynamic scattering mode), TN (twisted nematic), STN (super twisted nematic), TSTN (triple STN), FSTN (film STN), TFT (thin film transistor) and MIM (metal insulator metal) LCDs.

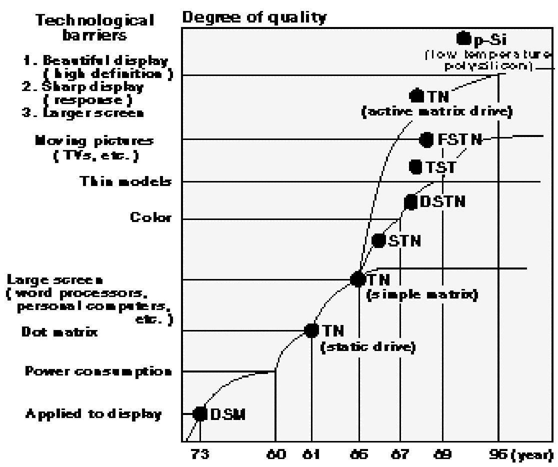

Figure 3: LCD technology evolution (Sharp technical library).

Newest LCD technologies offer very high image quality at consumer prices (figure 4).

Figure 4: Sharp color LCD example.

2.2 ELECTROLUMINESCENT DISPLAYS

Electroluminescent display use zinc sulfide or other materials that emit fluorescence when voltage is applied to them. At the moment, available EL displays can emit green, red or yellow light. Full color versions will be available in a close future based in the development of new phosphor layering technologies using chemical vapor deposition processes.

EL displays (figure 5) offer some advantages over LCD displays:

- High resolution.
- High contrast.
- Fast response.
- Very wide viewing angle.

And present some disadvantages:

- No true color display available.

Figure 5: Planar EL display example.

3. INTERFACING A FLAT PANEL DISPLAY

Flat panel displays are commonly used as part of microprocessor systems. To provide the interface between the flat panel and the microprocessor we need to use a video controller.

The video controller (figure 6) interfaces the microprocessor bus like a microprocessor peripheral and provides the necessary control signals to drive the flat panel display.

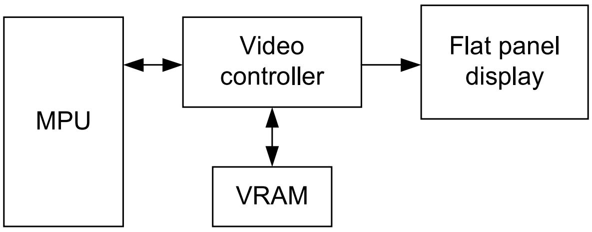

Figure 6: Interfacing a flat panel display.

The video controller presents the flat panel display to the microprocessor as a linear memory where all display pixels are mapped. This linear memory is named video RAM (VRAM) and the flat panel display resolution and color depth determines the required size.

Example: 800x600 pixels display with 256 colors per pixel. To obtain 256 colors per pixel eight bits per pixel are needed. In eight bits per pixel mode each byte of display buffer represents one pixel on the display, the complete display area is mapped into a buffer of 480,000 bytes.

4. APPLICATION: MONITORING SYSTEM USING AN EL DISPLAY

We have developed a custom medical monitoring module for an assisted ventilation system using an EL display. The high resolution and contrast, the fast response and the very wide viewing angle of EL displays make them very adequate for medical monitoring applications.

The monitoring module fits the generic flat panel display interface proposed in figure 6. It includes a Motorola 68000 MPU [3], a S-MOS SED1353 video controller [4], 128 Kbytes of video RAM and a Planar EL 640x480 display [5].

The SED1353 video controller provides a versatile and configurable bus interface for common MPUs (Motorola, Intel, Zilog). They supports LCD and EL displays and uses static RAM as video buffer memory (figure 7).

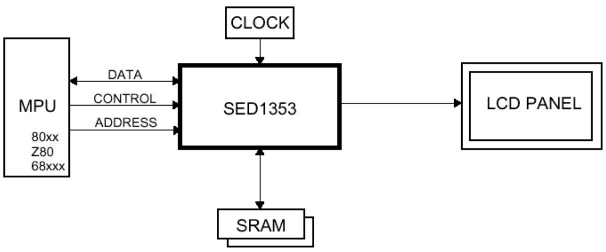

Figure 7: SED1353 system block diagram.

The developed application (figure 8) monitors respiration parameters as pressure, flow and volume. They show real time and trend calculated parameters. The application uses a user-friendly interface that makes use of a rotary position encoder as input device. The rotary position encoder includes a push button and allows one-hand navigation trough the application interface menus.

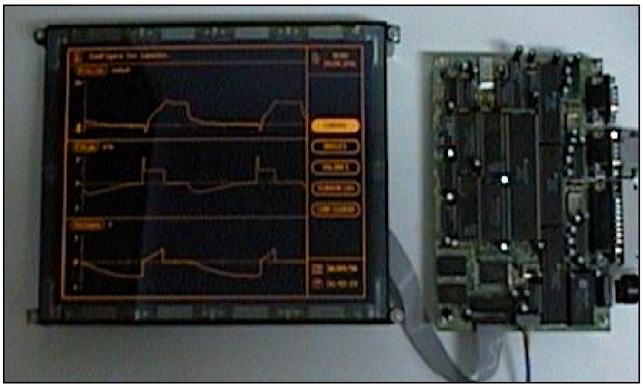

Figure 8: EL display base monitoring system.

5. APPLICATION: TFT COLOR DISPLAY BASED SYSTEMS.

As mentioned before, high resolution and contrast, fast response and very wide viewing angle are the advantages of EL displays over standard LCD displays, but new technologies currently available offer enhancements than improve the basic LCD features. One of the newest technologies, the thin film transistor (TFT), offers similar features to EL displays. High contrast, high picture quality, high response and good viewing angle (lower than EL displays but acceptable for medical applications) are achieved with TFT displays. But the best feature available in TFT displays is that they are capable of true color display. True color images can be displayed in TFT displays, in comparison with limited color capability of EL displays.

The true color feature allows for richer and fancier application user interfaces, but most important, it allows more information to be showed on screen at the same time.

The constant improvements in TFT technology and the lowering price market tendency predict a wide use of TFT flat panels in all kinds of applications.

True color displays demand powerful video controllers that support more video RAM (color depth increase involves more bits per pixel) and higher clock frequencies. We are working with the S-MOS SED1355 video controller [6] to drive a Sharp TFT 800x600-color display [7].

The SED1355 video controller provides a configurable bus interface for common MPUs, supports LCDs, EL and CRT displays and uses dynamic RAM as video memory to increase video buffer capacity (figure 9). Dynamic RAM is cheaper and available in much higher densities than static RAM.

6. FUTURE LINES: TOUCH SCREEN PANELS.

Touch screen panels are one of the newest input devices available on the market. The touch screen is placed over the flat panel display as a filter (figure 10) and allows user interfaces based in direct finger touch (figure 11) over the screen, thus the external keyboard is no longer required. The result is a very intuitive user interface. Users can use menu-based applications immediately.

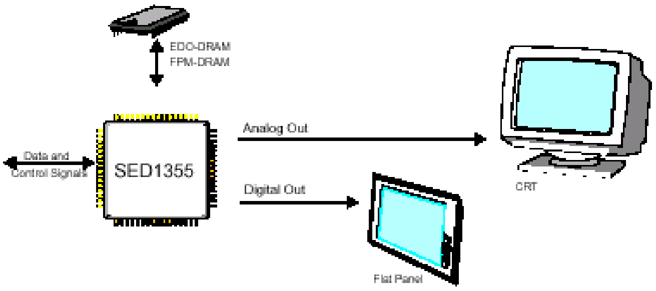

Figure 9: SED1355 system block diagram

There are a number of distinct touch panels that differ on the types of materials and the touch detection method they use [8]:

- Analog resistive.
- Capacitive
- Scanning infrared.
- Surface wave.
- Near field imaging (NFI).

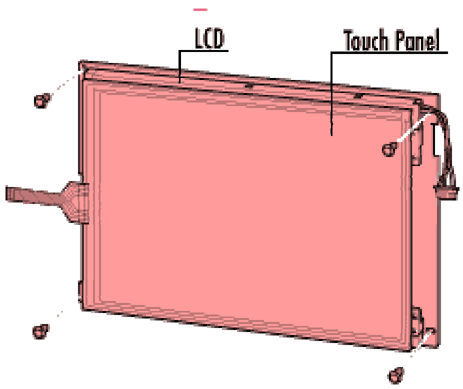

Figure 10: Touch screen and flat panel display mounting

Analog resistive touch screens (figure 11) are the most common due to the good relation between features offered and market price. They have a flexible top layer and a rigid bottom layer separated by insulating dots, with the inside surface of each layer coated with a transparent metal oxide. Voltage applied to the layers produces a gradient across each layer. Pressing the flexible top sheet creates electrical contact between the resistive layers. The control electronics alternate voltage between the layers to get the x and y touch coordinates [10].

In near future it is easy to predict flat panel displays with integrated touch screen panels that allow simple interface at low cost, replacing bulky keyboards and mouse pointers.

7. Conclusion

The enhanced capabilities of flat panel displays are allowing his use in a lot of applications from calculators and digital watches to televisions and computer equipment.

Medical applications demand monitoring systems for vital sign monitoring and bedside administration. The flat panel displays can offer some advantages over traditional CRT monitors in this kind of applications: less space and lower power consumption but at the same or higher image quality.

Also, medical applications demand user friendly interfaces. The use of intuitive input devices like rotary position encoders and touch screen panels offers simplicity replacing bulky keyboards.

A custom medical monitoring module for an assisted ventilation system using an EL displays has been successful developed, and is already available on the market. New monitoring systems for anaesthetic machines are currently under development using TFT based displays.

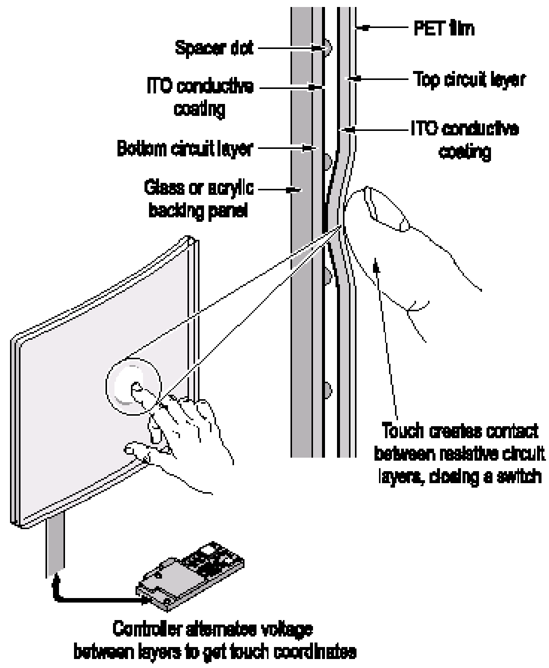

Figure 11: Analog touch screen detail (Dynapro technical library).

Acknowledgment

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