# 11.4 A Large Screen Color Display Using an Array of LCD Modules

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## Introduction

We have developed a new large screen full-color video display system using liquid crystal display devices, for use in indoor open spaces. The developed display has flat, thin screen structure and presents clear full-color pictures.

A number of large screen full-color displays have been proposed and developed, especially projection displays are found successfully their uses in application fields as educational, theatrical, command control displays and also in home tv-sets. But, the projection displays which require relatively long projection distance and relatively high reflectance screen are limited their uses to "closed spaces" where lighting environments can be controlled.

For the ultra-large screen displays, matrix type displays using an array of light emitting devices such as flood-beam CRTs have been developed.[1] However, their primary application fields are in large open spaces such as sports stadiums, because their relatively large pixel requires very long viewing distance.

On the other hand, advances in the liquid crystal display (LCD) technologies proliferate application field of the LCD. A recent paper reports a large screen display for the message center using a matrix array of LCD-cells.[2] But it is limited to monochromatic character displays.

This paper describes the developed display system, named "CRYSTAL COLOR" ("SPECTUS" in Japan). The display has a modular structure, where the modules of LCD panels having 8 x 64 pixels are assembled to build up full size screen. The display is suitable for the applications in which the viewing distances are located between conventional projection displays and ultra-large screen displays.

## System configuration

The developed display system is divided into two sections, the one is an operational-control section and the other is a screen section. Figure 1 shows the block diagram of the system. The operational-control section consists of video, audio, and computer subsystems. The video subsystem, consisting of various video equipments with a video switcher, produces signals of video pictures. The computer subsystem produces signals of character messages and/or graphic pictures. The computer subsystem also controls the system operation including job scheduling. These signals are fed to the screen section and displayed on the screen. The video pictures and the character/graphic pictures can be displayed individually or overlapped under control of the computer subsystem. The audio subsystem is also equipped to have more effective communications.

The screen section consists of a picture controller and a display screen. The picture controller includes A-to-D converters for the color video signals and video- and character/graphic-buffer memories, and distributes the signals to the driving circuits of the display screen.

The display screen is an array of self-contained screen modules and described below.

## Screen structure

The display screen is made up of the self-contained screen modules, each module containing a transmissive LCD panel, its driving circuits, and a illuminating apparatus. The LCD panel constitutes a part of the surface of the display screen. The screen modules and the supporting frame are designed to maintain the continuity of displayed pictures without any perceivable dead space between panels, when the modules are assembled to make up a large screen. The screen structure is shown in Figure 2.

Each LCD panel has a rectangular array of 8 x 64 pixels. The pixels are arranged to have equal separations between all adjacent pixels for maintaining the picture continuity even when the LCD panels are assembled into the screen. The pixels are arranged at intervals of 7.2mm. The pixel dimensions are determined also considering the planned viewing distance and the present production technologies of the LCD panels. The size of the LCD panel is approximately 60mm x 460mm.

TN-type liquid crystal is adopted from the aspects of its fast response and good reliability. The response time of the developed liquid crystal is about 30ms.

Each pixel is made of three subcells of primary colors, red, green, and blue respectively. The color of each subcell is set by an optical filter. The CIE 1931 chromaticity coordinates of emitted light from the subcells are (x=0.65, y=0.34) for red, (x=0.26, y=0.64) for green, (x=0.17, y=0.16) for blue. The luminance of each subcell is controlled to reproduce various color tones by additive mixture of color stimuli. The range of color reproduction is inside of the triangle made of the vertexes of above-mentioned coordinate values and shown in Figure 3. The coordinate values are determined considering both of wider reproduction range of colors and higher transmittance of the cell. For controlling the transmittance of the subcells, they are driven by a static drive method to obtain higher contrast and wider viewing angle of the pictures.

Behind the LCD panel, illuminating apparatus is installed which illuminates the screen from inside. The illuminating apparatus consists of a fluorescent lamp, a diffuser placed just behind the panel, and a reflector-diffuser between the panel and the lamp. The illuminating apparatus realizes a high degree of luminance uniformity on all over the display screen with high luminance level. Use of 3-band type fluorescent lamp is advantageous in realizing the better color quality and higher luminance level.

## System characteristics

Five standard screen sizes, approximately from 0.9m x 1.4m to 2.9m x 4.6m, are available for use as shown in Figure 4. The depth of the screen is approximately 0.4m including its frame. The screen of the system has lower diffuse reflectance than projection display screens. The system can be much less influenced on the visibility of pictures by lighting environments. It was found more than 10 gradations could make sufficient color reproductions of pictures. The system refreshes pictures at 30Hz. No problem could be found about the response of pixels at this rate even in rapid motion pictures. The range of viewing angle is ±45° on the horizontal plane. Sufficient picture quality was obtained within the range. The range of viewing distance was found to be more than 3m in case of pictures by digital signals and more than 6m in case of pictures by video signals from subjective evaluations. The white tone luminance level is approximately 250cd/m². The power consumption of the system is approximately 1kW/m².

## Conclusion

An example of the stand-alone system of "CRYSTAL COLOR" is shown in Figure 5.

The system can be more suitable in fields where 10 to 1000 people see the display at the same time according to the range of viewing distance. The following fields are more applicable for the system; advertising and sales promotion fields as shopping centers and department stores, information service fields as airport and public spaces, information control fields as control systems of power stations and transportation control systems, event-representation fields as theaters and sports arinas.

It is important for this kind of system to prepare softwares which match both an object of the application and characteristics of the system. We are planning to continue our research in this field.

## References


(1) K.Kurahashi,et al.,"An Outdoor Large Screen Color Display System", '81 SID Tech. Digest 13.1

(2) J.R.Burns,et al.,"Liquid Crystal Message Center Display", '83 SID Tech.Digest 7.3

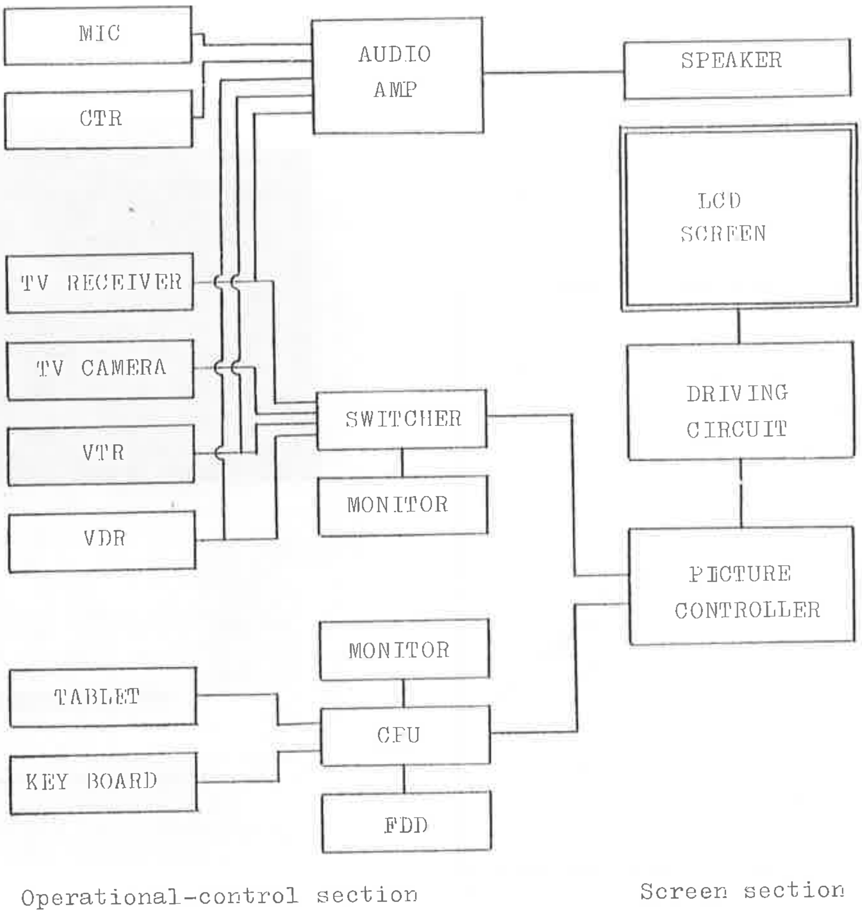




Figure 1 Block diagram of system

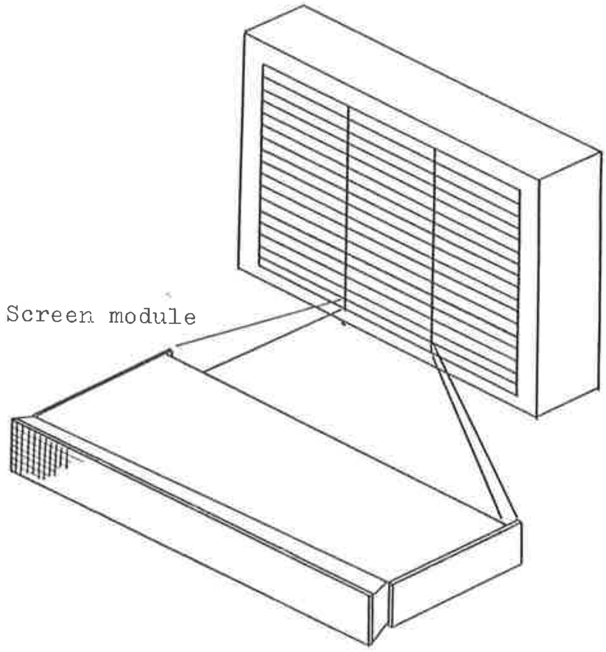
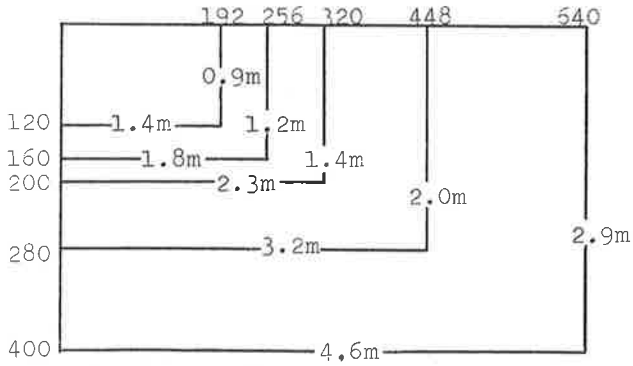



Figure 2 Screen structure




* Figures written at the outside of frames designate number of pixels arranged to build up screens.

Figure 4 Standard screen sizes

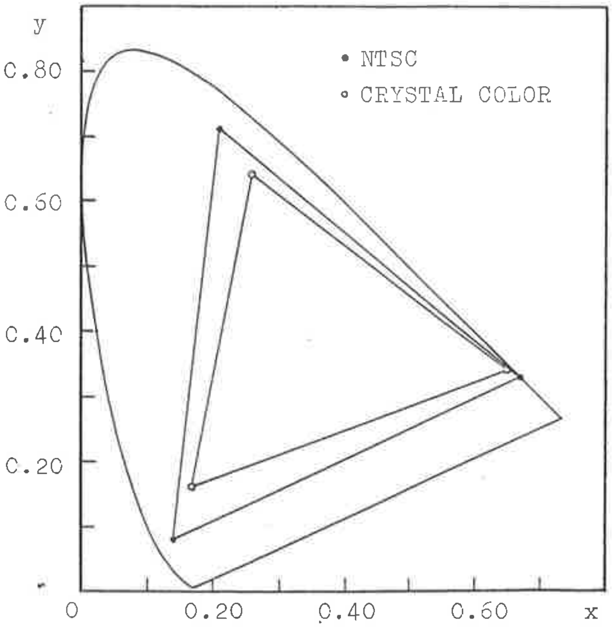



Figure 3 Range of color reproduction

Figure 5 Stand-alone type of CRYSTAL COLOR