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## The Reflective Type of Electronic Whiteboard Based on Cholesteric Liquid Crystal Display Technology

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**Abstract:** The study analyzes the basic principle and structure of cholesteric liquid crystal display technology and concludes features and requirements of reflective type of electronic whiteboard based on cholesteric liquid crystal display technology. The design of drive circuit of reflective type of electronic whiteboard; the make-up of large reflective type of cholesteric liquid crystal homogeneous display screen as the display equipment of electronic whiteboard; and the adoption of C language to edit systematic software according to the standard of software engineering contribute to the interactive function of electronic whiteboard of cholesteric liquid crystal.

**Keywords:** Cholesteric liquid crystal, display, electronic whiteboard, reflective type

### INTRODUCTION

Liquid crystal refers to some organic compound between the solid and liquid state possessed with different optical characteristics sensitive to the external electronic fields, magnetic fields and temperature. Taking liquid crystal as the display materials and utilizing the optical rotation of liquid crystal molecules, the LCD controls the lights to show text, graphics and images through an array of liquid crystal photic gate. Due to the specific structural arrangement of molecule, cholesteric liquid crystal possesses some special optical phenomenon such as waveguiding effect, Bragg reflection and rotation effect. Ordinarily, the cholesteric liquid crystal alignment can be divided into three types. The 1<sup>st</sup> one is planar texture called the "P" state; the 2<sup>nd</sup> one is Homeotropic texture called the "H" state; and the 3<sup>rd</sup> one is Focal conic texture called the "FC" state or nematic conic texture induced by a magnetic field. Therefore, the cholesteric LCD made from cholesteric liquid crystal is regarded as a bistable display. If the electrodes on the back of the cholesteric LCD are divided into some mineral image elements (pixels), the image can be viewed by applying voltage towards each region of the display to generate graphics in reflection and absorption regions (Shi, 2008). The bistable cholesteric liquid crystal reflective display screen can adopt the passive matrix drive and do not need voltage to sustain after the drive to display images.

### CHOLESTERIC LCD

Cholesteric LCD possesses several advantages as follows: it utilizes bistable display in zero field without refreshment; it also does not require the backlight with lower power; bragg reflection display is adopted to

easily realize the requirement for color; Polaroid is not needed, thereby greatly improving the brightness of the display; in zero electric field, each pixel can display a reflection with a long-term stability in different states and the application of appropriate voltage can achieve transitions in various steady states and grayscale display; the view is wide and the simple drive circuit can realize a multi-level multiplex drive with high density. However, 2 main problems still exist in the cholesteric LCD, that is, the drive voltage is relatively high and the respond speed is slow within milliseconds and even dozens of Ms which is only suitable for the static display rather than animation and video display. Because of the above characteristics, the cholesteric LCD has been applied mainly in low-power portable devices or monochrome display signs for many years.

**The structure of cholesteric LCDL:** The cholesteric LCD is mainly made up of placode, cholesteric liquid crystal and sealing materials. Two pieces of placodes of experimental liquid crystal display board adopt the front glass substrates of 46 inches, 16:9 wide screens PDP (Plasma Display Plate) with both the same ITO (Indium Tin Oxides) transparent electrodes. The 2 PDP front glass substrates should be manipulated respectively to make the flat conic state of cholesteric liquid crystal stable. The upper substrate of the display region is covered with polyamides'. After the solidification, friction with a proper strength should be implemented to acquire better device contrast (Wei *et al.*, 2008). While the back of the underneath substrate is coated with a black absorbing layer so that the cholesteric liquid crystal reflection in the plane conic state is visible to light and the liquid crystal device can turn into a lighted state. When in focal conic texture, the cholesteric liquid crystal does not reflect the visible

light, instead the visible light is collected by the backward absorbing layers and then the liquid crystal device turns into black state.

Actually, the cholesteric liquid crystal is configured compositely by many materials including C6M polymerizable liquid crystalline monomer, SCL-1717 nematic liquid crystals and S811 chiral compounds of left optical activity and Irgacure651 light trigger. Adjusting the containing of S811, the cholesteric liquid crystal can be compounded into screw-tuck gradient in order to reflect the visible lights with the wavelength from 400 to 750 nm (Yang *et al.*, 2009). After dealing with the upper and underneath substrates of liquid crystal display board, both substrates should be accurately connected with each other, then heated and filled with the configured cholesteric liquid crystal materials. Finally, the substrates should be sealed with fluid sealant and solidified after refrigeration. The display panel is connected with drive circuit through a flexible printed circuit board, adopting ACF (Anisotropic Conductive Film) materials to realize a reliable connection of circuit with high density.

**Drive circuit:** The physical characteristics of reflective type of cholesteric liquid crystal display screen determine the requirements of its basic drive waveform. The amplitude and width of drive voltage should be high enough that the cholesteric liquid crystal can be driven to a vertical arrangement. The fall-off rate of driven pulse should also be controlled that the lower the fall-off rate is, the more possible the focal conic texture can be acquired; and the higher the fall-off rate is, the more possible the plane conic texture can be acquired. The methods of driving the reflective type of cholesteric liquid crystal display screen are mainly divided into passive one and active one (Yang, 2008).

The P state refreshment is adopted in the experiment to make use of existed PDP row plus column driver IC to reach the displaying requirements. The cholesteric liquid crystal driving circuit adopts the passive drive method. In order to realize the overall display of the screen, the row plus column matrix is utilized as the data driver. When an image is needed to reflect visible light, we should select the respective row plus column electronic polar and apply specific voltage to realize the reflection of visible lights. Therefore, the drive circuit has the effect on opening appropriate voltage switch to apply row plus column voltage towards cholesteric liquid crystal according to image signals. The drive circuit includes output circuit of row scan drive, output circuit of column scan drive, row plus column controller circuit, MCU (Micro Control Unit) and data memory circuit and so on. The output circuit of row scan drive is applied for driving the selected row electrode poles. And the output circuit of column scan drive selects each image of rows according

to the selection of rows. The width of signals of the drive pulse of each image is limited by the image signals, which can ensure the situation of reflection lights for each image.

In the experiment, we utilize the type of uPD16337 row driver and the type of uPD16305 column driver. The uPD16337 refers to a CMOS (Complementary Metal-Oxide Semiconductor) driving icon with high press and low power consumption including a 64-bit bi-directional shift register, 64-bit latch and CMOS high-voltage driven part of the maximum 150V. The uPD16305 also refers to a CMOS driving icon with high press and low power consumption covering a 40-bit bi-directional shift register, latch and CMOS high-voltage driven part of the maximum 200V. The resolution of the display panel is 640×480 and the row driving electrode pole needs 640 output cables driven by 10 pieces of uPD16337. While the column driving electrode pole needs 480 output cables driven by 4 pieces of uPD16305. According to the controlling signals, the driven circuit transfers the TTL (Transistor-Transistor Logic) level signal to the pulse voltage necessary for the electrode pole and then some images can be formed in the cholesteric liquid crystal display screen.

**The reflective type of electronic whiteboard of cholesteric liquid crystal:** The electronic whiteboard is considered to an important teaching method with the combination of traditional and modern teaching approaches, which closely connects the multi-media teaching with traditional one. Thus, it has been adopted by more and more schools and become an indispensable method for modern teaching areas, playing a critical part in the process of information technology education (Zhang, 2008). Adapting to current technical development, the electronic whiteboard has brought advanced technology and interactive electronic platform into the normal teaching environment, cultivating the electronic whiteboard to be a newly industry. The present electronic whiteboard mainly makes use of DLP projection, LCD projection, CRT projection, PDP display screen and so on, which are all based on electroluminescent display screen with constant refreshment form at more than 50 times per sec. And the display system itself can be luminous. Thus, browsing for a long time will cause visual fatigue which damages ones' vision, affects the enthusiasm for learning and is not appropriate for people to browse continuously.

Since we take the monochrome screen of reflective type of cholesteric liquid crystal at the large screen to be the display device of electrode whiteboard, it possesses the following characteristics. Because of slow respond speed of cholesteric LCD, it has not received broad application for a long term. But as the electrode

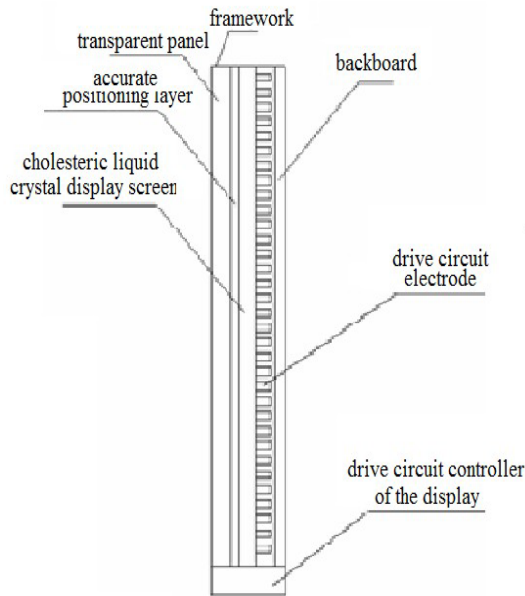


Fig. 1: The reflective type of electronic whiteboard of cholesteric liquid crystal

whiteboard, the cholesteric LCD has its particular advantages. People usually spend more than 2 minutes on reading one page of electrode whiteboard, which make the cholesteric LCD stretch its characteristics. During this period, the display screen does not need any power consumption. Meanwhile, without continuous refreshment, the images on the screen do not twinkle just like writing books. People can feel like viewing the images on the traditional blackboard (Li, 2009).

The luminescent display system needs to give off its own light, so it can still work normally in poor light. However, with the increase of the intensity of the ambient light, the effects of the luminescent display system become inconspicuous. And in the practical application, the intensity of ambient light changes from 100lux to 45000lux with a huge span. If the luminescent display screen wants to maintain the readability under such a wide range, it is necessary to adjust the light source to a very strong range or shelter from the light with curtains that may make people hard to read books and materials and even take notes in a dark ambient light. Actually, the cholesteric liquid crystal display shows images through reflecting the ambient light. The brightness of images will change in accordance with the intensity of ambient light, so does the contrast. In a normal classroom with a wide range of light, the reflective cholesteric liquid crystal display has more obvious advantages.

The structure of reflective type of electrode whiteboard based on the technology of cholesteric liquid crystal display is clearly described in Fig. 1. It is configured by transparent panel, accurate positioning layer, monochromatic cholesteric liquid crystal display screen, drive circuit electrode, backboard and framework.

The system controls the display through interacting between controller and the host and generating timing of each drive signals at the same time. The connectors of the display modules adopt the uniform addressing method with the system. Having access to the internal control register through different addresses, the display module can achieve many sorts of functions.

**Interactive function:** Only if its display devices fit for the reading habit shaped for a long time and also possess interactive function, the cholesteric liquid crystal electrode whiteboard can really enter into people's life and receive people's popularity. Relying on the technology of the accurate positioning test below, such as the electromagnetic induction for the technology of test of accurate positioning, the infrared ray for the technology of test of accurate positioning, the resistive film for the technology of test of accurate positioning, the ultrasonic wave for the technology of test of accurate positioning and the optical scanning of CCD (Charge Coupled Device) for the technology of test of accurate positioning, the reflective cholesteric liquid crystal electrode whiteboard can realize interactive communication and operation between electrode whiteboard and computer.

Combining with the different circumstances of accurate positioning technology, the system extracts the time-delay information from the received signals with varied arithmetic methods. In the design of the system, the analog part and digital part adopt independent solution respectively. The analog part mainly takes the responsibility of receiving and enlarging. Combining with the chips like peripheral logic control, A/D conversion and asynchronous communication, the digital part takes DSP (Digital Signal Processing) as the core chip to jointly complete ultrasonic signal sampling, processing and activity detection, extraction of color and time-delay information; communicate the host computer; and even accurately extract the time-delay information of the sign pens in real time. Then, the software part is mainly applied to finish the data acquisition, process, activity detection and time-delay extraction algorithm. In order to effectively make use of the advantages of DSP and consider the predictability of consumption of positioning algorithm, we can adopt C language to edit systematic software according to the requirements of software engineering and rely on DSP which develops the tool of CCS (Common Channel Signaling) for realization. Considering the requirements of real-time in the design of algorithm, we typically use indirect addressing and cycle addressing on purpose of fully utilizing resources of DSP itself and improving the real-time of the algorithm.

Maintaining the function of arbitrarily writing in the traditional blackboard, the cholesteric liquid crystal electrode whiteboard that realizes the interactive function can record everything on the whiteboard in real-time and make the dusk-free, pollution-free

education with induction pen or fingers instead of mouse or chalks come true. It also contains a variety of interdisciplinary data, common background gallery and chained library to support education in extensive areas. Moreover, it can connect with computer, camera or other video players through wireless and wired interfaces, greatly and efficiently realizing the share with hardware resources and information resources.

### CONCLUSION

As a matter of fact, LCD is only 1 of the display techniques as the reflective type of electrode whiteboard. Besides the LCD, others are applied in the implementation including electro phoretic display technology; MEMS display technology; electro wetting display technology, electro chromic display technology, fluid display technology, electrochemical display technology etc. And the realizations of LCD technologies of reflective type of electrode whiteboard are also varied such as cholesteric liquid crystal display, bistable twisted liquid crystal display, vertical bistable liquid crystal display and ferroelectric liquid crystal display (Wang, 2006). Actually, each technology has its own characteristic and advantage. But the research on the liquid crystal display technology is much more mature. And the cholesteric liquid crystal display technology can use many traditional LCD techniques as

a source of reference, which can be much easier for the cholesteric liquid crystal display technology to cut into the product market.

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