Research on Electric Heating Shielding and Sunlight Visualization of LCD Display Based on Machine Vision

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Abstract: Due to the widespread popularity of interactive electronic products, the requirement for flat panel display becomes higher and higher, so the visibility of display screen becomes particularly important. Therefore, based on machine vision, the author studies the electric heating shielding of LCD and the visibility in sunlight. The results show that high brightness is the only way for airborne LCD to be visible under direct sunlight, especially in open cockpit. Machine vision, as an advanced automated inspection technology in the field of information science and technology, can improve production efficiency and industrial manufacturing. Improves the contrast of the display in strong sunlight, enabling the LCD to be visible in the sun. At the same time, the production yield is improved, the quality is more stable, and the reliability is higher, which enhances the competitiveness of the liquid crystal display in the fields of high-end and outdoor.

1. Introduction
The airborne liquid crystal display needs to have high brightness, micro brightness, automatic dimming, high color temperature, night vision compatibility, good uniformity, wide temperature work, low power consumption, low air pressure work, high seismic resistance, high reliability and so on [1]. The LCD screen is the core component of the liquid crystal display. There is a polarizer on the front and back of the LCD panel, especially the front polarizer is exposed. The shielding of the display window is a problem that must be solved [2]. In practical applications, in order to protect the liquid crystal display, the plastic casing is often used for fixing. Therefore, the distance between the liquid crystal display area and the outer casing is one of the important criteria for measuring the quality of liquid crystal displays [3]. Based on this, in recent years, the replacement of flat panel display devices is faster and faster. The early CRT display is gradually replaced by LCD, and the LED display is also rising. The latest display devices include OLED and 3D display [4]. Airborne liquid crystal display (LCD) in high altitude and strong sunshine, especially in open cockpit, is generally not abrasive-resistant due to the production process and material characteristics of polarizer. It is easy to degum and denaturation when wet, and can not be directly used for outdoor display [5]. Therefore, it is necessary to add a protective lens or touch screen before outdoor LCD. High brightness is the only way to realize visibility in strong sunlight. This paper will discuss the highlight design of airborne LCD.

As an important part of digital products, the quality control of LCD is more and more stringent [6]. As we all know, liquid crystal display (LCD) is a kind of display that does not emit light on its own. As a passive display device, it is realized by modulating external light. At present, most of the LCD is used through LCD [7]. If the cover plate is bonded to the LCD screen with the mouthpiece glue, an air layer will be formed in the middle. High-end LCD display needs to adapt to various harsh environments, such as climate, mechanical environment, electromagnetic environment and biological
environment, on the basis of wide temperature performance, high and low pressure resistance, vibration and shock resistance, isolation and sealing anti-salt fog fungi, etc. [8]. It also needs special functions such as anti-electromagnetic interference and anti-information leakage, anti-frost defogging and low temperature start, and clear visibility in outdoor sunlight. It enhances various functions such as “electric heating”, “electromagnetic shielding” and “visual under sunlight”. Characteristics [9]. Due to the large output of the liquid crystal display, the cleaning degree and the dimensional detection precision are required to be high, and the manual detection has the disadvantages of slow detection speed, low precision, subjective influence of the detection result by the tester, high false detection rate and high miss detection rate [10]. Therefore, the detection of flat panel display is an indispensable part of the production and development process. The industry urgently needs a good quality identification method for flat panel display.

2. Characteristics and Application of Machine Vision
The characteristic of machine vision system is to ensure the reliability of production and realize automatic production. In the process of large-scale industrial production, using machine vision detection method instead of manual vision which is inefficient and poor in accuracy to inspect product quality can significantly improve production efficiency and automation production level. Machine vision is introduced into industrial inspection to realize rapid measurement of product size or position. It has outstanding advantages such as non-contact, fast speed and good flexibility. It has broad application prospects in modern manufacturing industry. In addition, machine vision is often used to replace manual work in some extreme conditions that are not suitable for human operation or in situations where human vision cannot satisfy. The detection of the distance between the liquid crystal display area and the outer casing is essentially the detection of the straight edge of the acquired image and the calculation of the detected distance of the associated parallel straight line. Machine vision that facilitates information gathering is the foundation for digital integrated manufacturing technology. The machine vision system does not require contact, and does not cause any damage to the detector and the object to be tested, thereby improving the reliability of the system. And the wide range of receiving spectra, such as the use of infrared measurements that are visually invisible to humans, extends the visual range of the human eye. At the same time, it can work stably for a long time. It is often difficult for humans to continuously observe the same object without interruption, while machine vision can measure, analyze and identify for a long time.

Machine vision systems typically include industrial cameras, light sources, lenses, and vision software that can be viewed as the eyes of a robot. Popular speaking is image processing. The electric heating shielding window is used to meet various requirements of the low-temperature heating start and anti-fog and defrosting requirements of the liquid crystal display. The structure is special, and the visible area size, loading voltage, design power and line resistance of the window should be accurately provided during design. Values and other related technical data, and proposed insulation resistance required to ensure safety. Compared with the air layer, the manufacturing process using the liquid optical glue reduces the glare (strong reflected light) of the liquid crystal display, increases the transmittance of the liquid crystal screen, thereby improving the contrast of the liquid crystal screen, especially under strong external light. The advantages are more pronounced and enhance the product's ability to withstand vibration shocks. In addition, factors related to determining the number of lamps include the loss rate of light. The purpose of heat dissipation is to prevent local overheating of the liquid crystal display. CCFL cold cathode lamp is the main heat source in LCD. Therefore, how to export and disperse the heat of the lamp tube as soon as possible and effectively is the problem we need to solve. The objects and areas that need to be detected are captured by the camera, and the captured objects are converted into image signals. In theory, machine vision is to replace human eyes with computer and vision sensors for measurement and judgment.

3. Visibility Principle and Optical Design of LCD in Sunlight
According to the principle of reflection, light will be reflected at the interface through two transparent
media of different refractive indices. The greater the difference in refractive index between adjacent transparent media, the higher the reflectivity at the interface. The difference in refractive index between the air and the cover plate and the polarizer of the liquid crystal panel is relatively large. Therefore, the specular reflectance of the display screen using the air layer is high, and the overall reflectance reaches about 12%, which causes strong glare, which causes the human eye to see the image content of the display screen. In the field of national defense, electromagnetic shielding windows are widely used in radar, cabin communication vehicles, aircraft, military computers, instrumentation, aerospace engineering, automation systems, etc. In the field of defense, sea, land and air. In order to reduce the reflectivity of the interface, the method of inserting a transition medium is usually adopted. When the refractive index of the medium is \( n = (n_0 \times n_1)^{1/2} \), the overall reflectivity is the lowest. Increase lamp current and 88B. The luminous efficiency of the lamp tube. For example, by reducing the wall thickness of the lamp, we can see from the characteristics of the cold cathode lamp that the finer the tube diameter of the straight-tube cold cathode lamp, the higher the luminosity, which is very helpful to enhance the brightness of the backlight. Multi-lamp technology is simply to increase the brightness by increasing the number of backlights. For the choice of optical adhesives, in order to achieve the lowest reflectivity at the interface, the refractive index of the selected optical adhesives must be between the refractive index of the LCD polarizer and the refractive index of the cover material.

It can be seen from Fig. 1 that the reflectivity varies greatly with different reflective coatings, and the reflectivity directly affects the brightness of the display.

![Figure 1 Comparison of characteristics of different reflection modes](image)

Of course, for the choice of optical adhesives, in addition to considering optical performance matching, we also need to consider structural reliability, environmental stability, process and other factors. Therefore, refractive index must be selected to meet the requirements, suitable for glass and polarizer materials with sufficient bonding strength glue to ensure the stability of the structure, and the working temperature range is wide. It can work normally at high and low temperatures without changing its properties and has high environmental stability. In the field of civil and commercial use, it can effectively solve the electromagnetic radiation of government, enterprise, banking system, securities system, scientific research laboratory, electric power, medical treatment, vehicle display windows to ensure information security. At present, the common commercial liquid crystal display light guiding system mostly adopts a side-light structure backlight, and the multi-lamp technology mostly adopts a parallel direct-type structure backlight. Therefore, the liquid crystal panel modified by the multi-lamp technology needs to be re-selected except for the entire light guiding system (light guide plate, reflective film, diffusing film, prism film), and the entire structure must be redesigned. In addition, the heat dissipation problem caused by multi-lamp technology also needs to be solved during structural design. An indium tin oxide film prepared by magnetron sputtering or the like on various
substrates, that is, an ITO transparent conductive film, has high light transmittance, no optical distortion, strong environmental adaptability, and the like, and has a low resistance of less than 14 Ω. The ITO film has a certain shielding function.

The electric heating glass can effectively realize the low-temperature heating start and the anti-frost and defogging function of the liquid crystal screen, and is used for various display windows that require electric heating. The conventional varieties are shown in Table 1.

| Varieties                             | Function description                                                                 | Transmittance | Using ITO Layers |
|---------------------------------------|-------------------------------------------------------------------------------------|---------------|------------------|
| Electric heating                      | Only with heating function                                                          | 85%           | 1                |
| Shielding by electrothermal coating   | With electric heating function and ITO conductive coating                            | 85%           | 2                |
| Electrically Heated AR/AG Antireflection Coating Shielding | On the basis of electric heating and coating shielding, anti-reflection function is added, i.e. anti-reflection and anti-glare AG film or AR+AS film. | 90%           | 2                |
| Electric heating clamp screen        | On the basis of electric heating, adding screen shielding function to meet GJB151A  | 50%~75%       | 1                |
| Electrically Heated AR/AG Antireflection Sandwich Screening | On the basis of electrically heated sandwich glass, the special function of anti-reflection surface vision is added, which is suitable for the display windows with anti-reflection requirements in outdoor (AR) or indoor (AG) and heating shielding requirements. | 50%~75%       | 1                |

The optical bonding technology of the LCD screen does not change the original brightness and structure of the LCD screen, only increases the thickness, and the thickness can be selected from 0.3 to 8 mm according to the requirements, effectively realizing the clear visual function of the LCD screen and various touch screen sunlight. The performance parameters of the bonding LCD screen are shown in Table 2.

| Project                  | Performance                                                                 |
|--------------------------|-----------------------------------------------------------------------------|
| Reflectivity             | Surface reflectance <1%                                                     |
| Transmittance            | AR glass used, its light transmittance is greater than 96%                  |
| Temperature-height test  | Temperature-height test (temperature 25 °C), height 1525 m (pressure 11.64 K Pa) |
| Vibration test           | Functional vibration (frequency 15~2000 Hz), direction X/Y/Z axis, time 1 h. |
| Environmental test       | High and low temperature storage (-55~+70 °C), high and low temperature operation (-40~+65°C), humidity (95%) |
| Impact test              | Sawtooth wave, acceleration 20 g, 11 ms                                     |
4. Conclusion

In order to further improve the factory quality and production efficiency of flat panel display devices, reduce cost and labor intensity, it is of great significance to apply machine vision to flat panel display detection. A line detection algorithm combining Hough transform and least squares method is proposed. The straight edges of the liquid crystal display area and the outer casing are effectively detected, and the distance between the fitted straight lines and the angle difference are calculated. The visible electromagnetic shielding electric heating window series products under sunlight can be applied to the high-tech fields of national key projects such as aerospace, information industry, CSIC, weapons industry, nuclear industry, satellite communication, medical care, and confidential communication. Through improved technology, the production yield is improved, the quality is more stable, the reliability is higher, and the mass production yield rate is over 88%. After our high brightness modification, LCD display can be used normally in high altitude and strong sunshine, especially in airborne environment. Enhanced the competitiveness of LCD in high-end, outdoor and other fields. The experimental results show that the proposed detection method is fast, efficient and accurate, and the algorithm has been successfully applied to on-line detection of assembly size of LCD. The display optical effect and anti-vibration performance of the display are greatly increased, and the contrast of the display under strong sunlight is improved. It is believed that with the rapid development of information technology and the emergence of new materials, high-performance liquid crystal display technology will have greater development space.

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