Basic Performance Judgment of Touch Screen

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Abstract. With the development of science and technology, intelligent devices are entering every corner of our life. As an intelligent terminal, the touch screen carries most of the functions of human-computer interaction, and the performance of touch screen is particularly important. Through the comparative analysis of the principles of several types of touch screens and combined with the production practice of the original electronic whiteboard touch screen, this paper summarizes several aspects of the performance of the touch screen, such as anti-interference ability, signal strength, positioning accuracy and line drawing quality. Taking the electromagnetic induction touch screen as an example, this paper analyzes the generation and classification of touch screen defects, and summarizes some defect judgment methods of touch screen, which provides ideas for the selection of touch screen and the improvement of the overall quality of touch screen.

1. Introduction

Touch screen, as a new type of computer input device, is currently the simplest, the most convenient and natural way of human-computer interaction. Touch screen is small in area, intuitive and convenient to use, which boasts many advantages such as sturdiness and durability, fast response, time-saving, and easy communication. Using this technology, the user only need touch the control area such as icons, symbols and text on the display screen with a finger or a special touch pen to achieve operation control of the host, thus making human-computer interaction more straightforward. This technology greatly facilitates users who do not master computer operations. Touch screen also gives multimedia a new look, which is an extremely attractive new multimedia human-computer interaction device widely used in public information query, office, industrial control, military command, video games, ordering of songs and dishes, multimedia teaching, etc., and gradually entering our lives. Through the comparative analysis of common touch screens, this article takes the electromagnetic induction touch screen that can represent most touch screens as the main line to find out how to judge whether the touch screen performance can meet our operating requirements.

2. Basic Principles of Touch Screen

Touch screen, also known as "touch panel", is a transparent absolute positioning system, while the mouse is a relative positioning system.[2] The characteristic of the absolute positioning system is that the coordinates of each positioning have nothing to do with the coordinates of the previous positioning. Touch screen is a physically independent coordinate positioning system. The position of each touch is converted to the coordinates on the screen. Regardless of the situation, it is required that the coordinate data output at the same point is stable, and the drift of the coordinate value should be within the allowable
range. By receiving input signals from touch pens, fingers, etc., the graphic buttons on the screen are touched, the touch feedback system on the screen surface can drive various connection devices according to pre-programmed programs to replace the mechanical button panel, thus achieving vivid audio-visual effects via the screen display.[3]

The basic working principle of the touch screen is as follows: When the user touches the touch screen installed on the display with a finger and a touch pen, the coordinates of the touched position are detected by the touch screen controller, and the touch information is transmitted to the PLC via communication interface (such as RS-232 or RS-485 serial port, USB interface), thus accessing the input information.

According to the implementation principle, touch screens can be divided into electromagnetic induction type, resistive type, capacitive induction type, infrared type, surface acoustic wave type, etc.[4] Where, the electromagnetic induction touch screen makes judgment based on the magnetic field changes generated by the electromagnetic pen during operation and the sensor under the panel. The electromagnetic pen is the signal transceiver, and the sensor is the signal receiver. When the electromagnetic pen approaches the sensor, the magnetic flux changes, and the coordinates of the touch location point are defined through calculations. Electromagnetic induction touch screens can be divided into active electromagnetic pen touch screen and passive electromagnetic pen touch screen according to whether the touch pen actively initiates electromagnetic signals or passively emits electromagnetic signals.

Compared with resistive touch screens, capacitive touch screens and infrared touch screens, electromagnetic induction touch screens have the advantages of high positioning accuracy and immunity from light and noise. The disadvantage is that it is susceptible to electromagnetic interference and operation with bare hand is not allowed, but corresponding electromagnetic pen must be used. The performance comparison and analysis of several types of touch screens are shown in Table 1:

**Table 1. Performance Comparison of Several Types of Touch Screens**

| Type                          | Working Principle                                                                 | Advantage                                                   | Disadvantage                                                                 |
|-------------------------------|-----------------------------------------------------------------------------------|--------------------------------------------------------------|----------------------------------------------------------------------------|
| Electromagnetic induction touch screen | It makes judgment based on the magnetic field changes generated by the electromagnetic pen during operation and the sensor under the panel. The electromagnetic pen is the signal transceiver, and the sensor is the signal receiver. When the electromagnetic pen approaches the sensor, the magnetic flux changes, the coordinates of the touch location points are defined through calculation. | High precision, allowing multiple pen operation at the same time, high resolution, sensitive response, good touch, waterproof, dust-proof, sun-proof | susceptible to magnetic field environment, it does not allow operation with bare hands. |
| Resistive type                | It uses pressure sensor to detect the touch point location                          | Able to withstand the interference of environmental factors in the second environment, it is not afraid of dust, water vapor and oil. | hand feel and light transmission are poor.                                    |
| Capacitive induction type     | It uses the human body as an electrode of the capacitor                              | High resolution, sensitive response,                         | There are problems of color distortion                                         |
3. Several Factors that Determine the Performance of the Electromagnetic Induction Touch Screen

3.1 Anti-interference capability
The working principle of electromagnetic induction touch screen determines that it is highly susceptible to the external electromagnetic environment. When the external electromagnetic noise exceeds the bearable strength of the device itself, the electromagnetic induction touch screen will produce cursor jitter, bend and jump at line drawing, and even cause failure of the touch unit.[5]

3.2 Electromagnetic signal strength
The electromagnetic induction touch screen mainly relies on the electromagnetic intensity change between the electromagnetic transceiver and the receiver to determine the touch position signal, and the electromagnetic signal intensity determines the device sensitivity.[6] The pen hanging height $H$ (that is, how far away the electromagnetic pen tip is from the screen when the receiver can sense the signal. Figure 1) is an important indicator of the sensitivity of the touch screen. If the signal is too strong, it is susceptible to interference and results in misoperation. If the signal is too weak, it is prone to disconnection and leakage operation.
3.3 Positioning accuracy
Positioning accuracy is an important parameter for judging the touch screen quality. The positioning accuracy mainly depends on whether the receiver receiving unit of the device has uniform layout and reasonable structure.[7] In addition, the installation precision between the touch unit and the display unit will directly affect the positioning precision of the device. Multi-point positioning is the main way to calibrate and detect positioning precision (see Figure 2).

![Figure 2. Positioning accuracy positioning point layout](image)

3.4 Pen-following speed
Pen-following speed is an important indicator for testing the touch screen sensitivity, that is, whether the line generation speed is consistent with the writing speed when a person normally writes on the touch screen surface. The distance L between the pen tip and the top of the generated line (as shown in Figure 3) reflects the pen-following speed. The smaller the L, the faster the pen.

![Figure 3. Pen-following speed](image)

3.5 Line Drawing quality
Line drawing quality is also an important way to check whether the receiver of the electromagnetic induction touch screen is evenly or invalid.[8] When testing, open the drawing software to draw diagonal lines, top, middle, bottom, left, middle, and right lines on the screen, and inscribed circles on the screen to observe whether the lines are bent, broken, or wrinkled (Figure 4 and Figure 5). The unreasonable layout of the device receiving unit is the reason for bending and wrinkling. The failure of the partial receiving unit is the reason for the disconnection.
4. Performance Judgment of Electromagnetic Induction Touch Screen

Combining the above five aspects, we can use the following methods to determine whether a touch screen meets the basic use requirements. Any failure to meet the requirements indicates that the touch screen has a system defect. Performance judgment and standards are shown in Table 2:

**Table 2. Performance Judgment of Electromagnetic Induction Touch Screen**

| Performance                  | Judgment Method                                                                 | Judgment Criteria                                                                                                                                 |
|------------------------------|--------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Anti-interference capability | Place the touch screen under a 40W tubular fluorescent lamp with a distance of 300mm between the two. | The cursor has no jitter at the moment the light is switched on and off. Turn on and off the light during the drawing process, and the drawing line has no bending or disconnection. After turning on the light for 5 seconds, there is no bending or disconnection in the drawing line. |
| Electromagnetic signal strength | When the pen hanging height $H$ is greater than 2 times of the distance          | Move it horizontally, and the cursor movement shows that the signal is too strong, highly susceptible to interference and prone to misoperation. |
|                              | When the pen hanging height $H$ is less than 1.5 times of the distance           | Move it horizontally, and if the cursor does not move, it indicates that the signal is too weak and prone to disconnection and miss operations. |
| Positioning precision | Open the software that can draw lines on the device and evenly distribute 9 circles with a diameter that is twice the diameter of the pen tip. | Click on the center of the circle with the pen tip, and the number of the cursor top in the circle is ≥7 |
|-----------------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
|                       | Open the software that can draw lines on the device, and evenly distribute 25 circles with a diameter that is twice the diameter of the pen tip. | Click on the center of the circle with the pen tip, and the number of the cursor top in the circle is ≥23 |
| Pen-following speed   | Draw a line on the screen at normal writing speed, as shown in Figure 3. | Observe the distance between the cursor and the pen, the distance between the cursor and the pen tip L≤the pen tip diameter |
| Line drawing quality   | Open the drawing software to draw diagonal lines, top, middle, bottom, left, middle, and right lines on the screen, and inscribed circles on the screen as shown in Figure 4 | Observe whether the lines have bending, wrinkles, or disconnections. |

5. Conclusion
With the technology development, touch screens have changed from exclusive use of electromagnetic induction type, resistive type, capacitive induction type, infrared type, etc. to combined use based on the advantages of various methods as needed. For instance, the combination of electromagnetic induction and infrared types, combination of electromagnetic induction and capacitive induction types, etc. are used to meet the requirements of different users. This article considers touch screen of some principles and the defects found in the production process to summarize judgment methods through comparative analysis, which may have limitations. With the continuous development of touch control technology, new functions will appear, and new defects will appear according to Murphy's law, so new judgment methods will also appear.

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