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Designment of new type anti-glare interference infrared touch screen of high resolution

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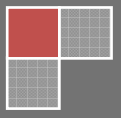
ABSTRACT

As an interactive output device, touch screen can be operated so easily that it is applied widely today when science and technology develop rapidly. Infrared touch screen designed with infrared light theory is a comparatively rare type of touch screen, mainly because interference caused by ambient light can seriously affect its working performance and can not achieve better resolution effect. These two defects badly hindered promotion and popularization of infrared touch screen. This difficulty drew attention of many researchers home and abroad. This study was based on basic design principles of infrared touch screen, designed and tested how to solve defects of infrared touch screen. The design direction is to develop a kind of infrared multi-touch screen with strong capability of anti-glare interference and with high resolution of course, the designing plan was testified. Infrared touch screen in the study could control transporting and receiving components real time through CPU. In front of receiving tube, collimated radiation channel channel was installed which reduced interference of ambient light with its light transformation direction and sensitivity; it could improve capability of anti-glare interference about three times. Realization of high resolution depended on corresponding location of touch points with received infrared light signal; resolution could be increased as 2045*768.

KEYWORDS

Interactive output device; Infrared touch screen; Multi-touch; Anti-glare; Resolution.



INTRODUCTION

As a technique which is used widely in the 21st century, in a large extent, touch screen replaces keyboard and mouse and becomes a new input device of computer; it is used in industrial production, media equipment, video games, restaurant, information query device and etc[1]. It can be considered as the most simple and convenient man-machine interaction technique. Information query user can complete relevant information verification through clicking on screen; it has high practicability and high-grade quality when it is applied for ordering system in restaurant; it is used in industrial equipments as embedded operating system, measuring system[2] and movable robot system[3]. There are five kinds of common touch screens at present: vector pressure sensor-based touch screen, resistive touch screen, capacitive touch screen, infrared touch screen and surface acoustic wave touch screen. Resistive and capacitive touch screens are thin film technology and are used the most widely. Through inserting glass plate, surface acoustic wave touch screen is made which has following defects: it can be affected seriously by light transmission; it is difficult to be maintained since it needs to be kept clean; it can only work for short time. Infrared touch screen decreases problems mentioned above in big extent and has high stability and accuracy. However, ambient light interference can seriously affect its working performance; its another fatal flaw is that not good enough resolution effect limits its development. Therefore, there is no perfect Infrared touch screen to meet demands of market; developing anti-glare interference infrared multi-touch screen is meaningful. In the study, bold and innovative design and validation were conducted with basic working principle.

PRINCIPLE AND DEVELOPMENT STATUS OF COMMON TOUCH SCREENS

Capacitive touch screen

In structure of capacitive touch screen, transparent thin-film conductor layer is plated on glass screen and add another glass protection layer; in this way both conductor layer and sensor layer can be protected completely; its serious drawback is reflection. Its operating principle is to confirm coordinate of touch point by measuring current percentage of four electrodes in location of touch point; it is mainly because that when user touch screen with finger, a tiny capacitive current of the touch point will be taken away[4]. Structural principle of capacitive touch screen is as shown in Figure 1:

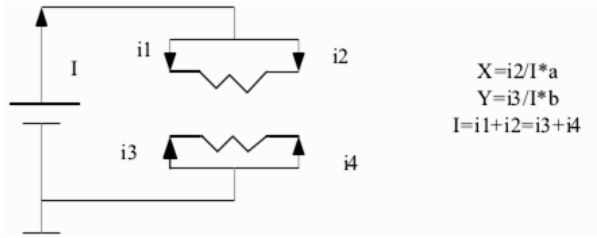


Figure 1 : Principle of capacitive touch screen

Capacitive touch screen is applied for a wide range of products such as most of Apple's products[5].

Resistive touch screen

Multi-layer compound thin-film is used in structure of resistive touch screen. Touching screen is controlled by sensor of pressure; when user touches screen, resistive change of touch point will calculated; coordinate of touch point (X, Y) will be determined after a series of calculation; it can be operated with hard object. Structure of resistive touch screen is as shown in Figure 2:

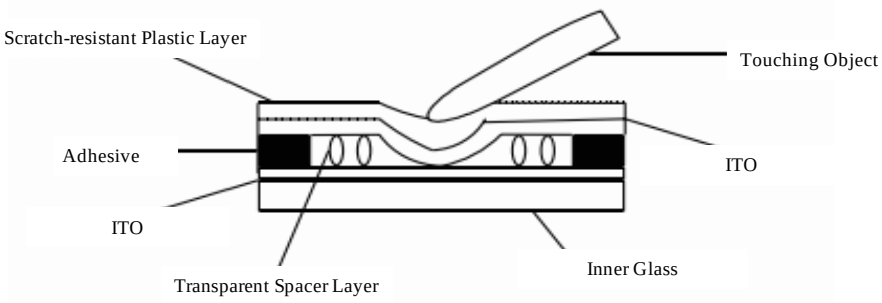


Figure 2 : Structure of resistive touch screen

Current resistive touch screen has high resolution, at the same time, it can withstand serious interference through plastic surface and glass bottom[6]; product costs low and can be produced conveniently. It is applied extremely widely, mainly in PDA, ATM, large-screen monitor and vending machine[7].

Surface acoustic wave touch screen

Surface acoustic wave is a kind of ultrasonic wave which is transported through medium surface[8]. Surface acoustic wave touch screen usually consists of touch screen, sound generator, transmitter and receiver. Its structure is as shown in Figure 3.

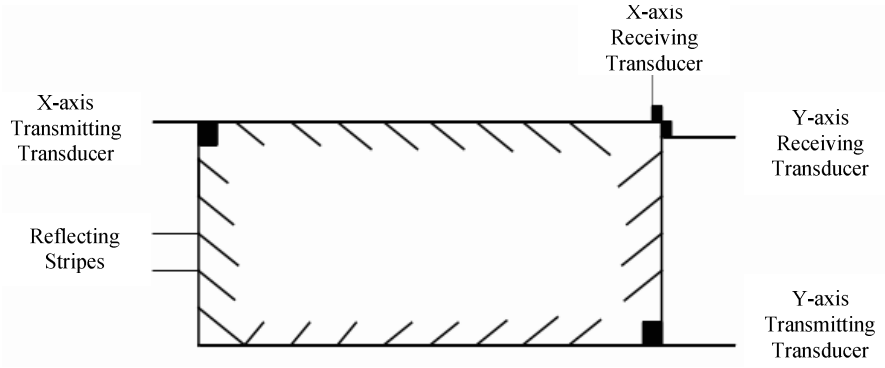


Figure 3 : Structure of surface acoustic wave touch screen

Infrared touch screen

Infrared touch screen consists of infrared emission components and receiving-sensing element. Light matrix is formed on screen and scanning is conducted constantly; when user touches screen, coordinate location of touch point can be judged. Its structure is as shown in Figure 4.

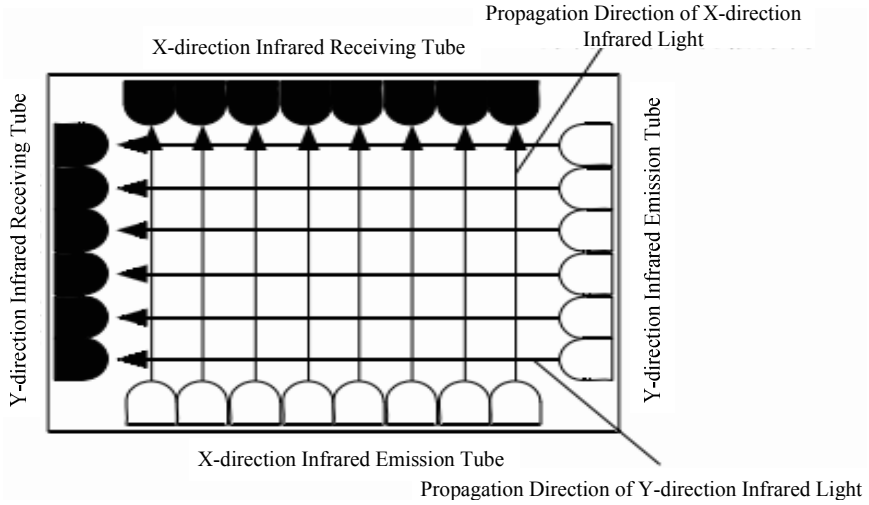


Figure 4 : Structure of infrared touch screen

Technique of infrared touch screen has been improved mainly in anti-interference and improving resolution. There are five stages in its development:

(1) The first generation infrared touch screen appeared in 1992 and its resolution was only 32*32, even environmental interference could cause misjudgment;

(2) The second generation infrared touch screen had a resolution of 64*64. It was withdrawn from market in 1994. Its anti-glare reference capability was improved largely and it could be used in some indoor environments;

(3) The third generation of infrared touch screen appeared in 1997. Although it could be applied outdoor, it could not be used under direct sunshine. It had a resolution of 320*240;

(4) In 1998, the fourth generation of infrared touch screen was launched. Its resolution had been developed into 800*600. But developments mentioned above were only based on defects of infrared touch screen, there were still problems needed to be solved;

(5) The fifth generation of infrared touch screen was a qualitative leap of product life and maintenance. Its had a life as long as seven years and its resolution was 1000*720. Moreover, it could be applied even under strong light.

Breakthrough development of infrared touch screen are constantly conducted in two aspects: quality and function. Its application area is widened, including industrial control, home appliances and etc. It can be said that infrared touch screen had stood ahead of other touch screens and were getting more and more attention. Appearance of infrared multi-touch screen

improved application and surviving capacity of infrared touch screen. These technological development also broke the pattern consisted of touch screens mentioned above; we can even predict that infrared touch screen will occupy 80% of market in future, that application of 4 inches and less will be occupied by resistive and capacitive touch screens and that surface acoustic wave touch screen will exit the stage of history.

DESIGN AND VALIDATION OF NEW TYPE INFRARED TOUCH SCREEN

Frame of hardware design

Infrared touch screen realizes its infrared light matrix through infrared emission and receiving tubes. Coordinate of touch point can be calculated by microprocessor. In the study, LPC2132 Chip was used as CPU; infrared emission tube was scanned through controlling 74HC595 Shift Latch; each corresponding infrared receiving tube was found by CPU through I^2C Bus Line; relevant value of light intensity was confirmed; finally, CPU calculated coordinate of final touch point and sent information to host computer via serial port. Its realizing way is shown as in Figure 5.

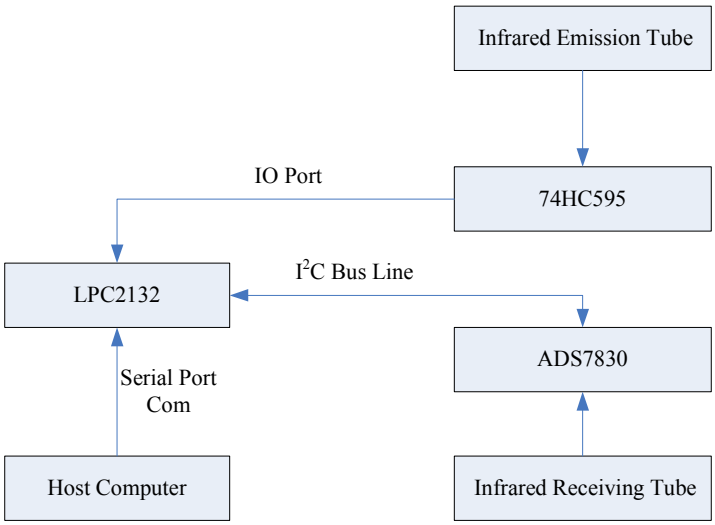


Figure 5 : Realizing principle of infrared touch screen

Micro-processing circuit is the core part of hardware circuit which includes JTAG Debug Module, Driving Infrared Receiving Module, Driving Infrared Emission Module and Serial Port Communication Module. Its main functions are as follows:

(1) Drive infrared emission and receiving circuit;
(2) Judge and calculate weather touch point occurred and specific coordinate information after occurrence;
(3) Transport coordinate information to host computer through serial port;
(4) Overall control and debug whole system.

Since common standard RS-232 Serial Interface is a non-balanced transmission which communication rate is low, it only suits for communication of local device[9]. In the study, standard RS-422 Serial Interface was used in serial port communication module which could realize point to point communication speed of 10Mb/S and transmission distance of over 1000 meters; it also supports point to multi-point both-way communication.

Infrared emission circuit uses infrared emission tube in which infrared emission tubes are lined in order of electricity quantity and each piece of 74HC595 Chip scans infrared emission tubes. In the study, EVERLIGHT Company's IR333C/HO-A was used as infrared emission tube. Main function of infrared receiving circuit is to collect signal of light intensity which is from corresponding infrared emission tube and to determine final touching data. ADS7830 Chip was used in infrared receiving circuit while PT334-6B was used as infrared receiving tube which was a phototransistor with high responding speed and sensitivity. Infrared emission and receiving tubes must be kept corresponding one to one all the time time and they play a key role in entire infrared touch screen work, misjudgment will appear once there is a mistake.

There are two kinds of module circuits: 5V and 3.3V. External power provides 5V power supply for system which is divided into two parts: one part is for infrared emission tube and 74HC595 Chip while the other part is transferred into 3.3V circuit for CPULPC2132 and Max3490 by transferring circuit. Moreover, power supply module shall be able to provide 2A output current.

Realization of high resolution

Calculation method of resolution is to times detected quantity of points in X and Y directions on screen. Resolution of infrared touch screen was determined by quantity of emission in early time, so it was low most of the time. In this study,

the intensity of received infrared signals was quantified and classified, calculated intensity of confirmed touching signals; corresponding intensity change happened even with tiny movement; in this way coordinate of touching point could be determined accurately and high resolution could be achieved. Resolution of touch screen was determined by quantity of infrared tubes and grade of intensity of light. Coordinate of touch screen is determined by both physical coordinate of infrared tube and corresponding coordinate of touching point[10].

Design of the study was tested by shutter device and structure device of receiving voltage as shown in Figure 6.

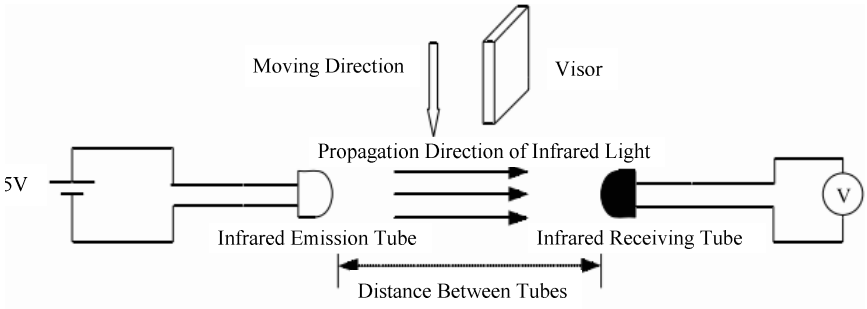


Figure 6 : Structure of testing device

According to final experimental testing data, if light intensity signal was thirty-two grade quantified, minimum resolution -- 0.0195 could be achieved. If size of applied infrared touch screen was 600mm*225mm, then its resolution was 2048*768. Resolution of touch screen can be improved largely in this way.

Realizing anti-glare interference

Infrared touch screen which is based infrared light principle is very sensitive to light interference. Since there are 50% infrared light in sunlight of real environment, misleading and misjudgment for touch screen will appear as soon as there is change of infrared light. Current solutions are adjusting circuit structure and physical light protection. The plan used in the study was to combine installing collimated radiation channel and dynamically adjusting area value. It could improve capability of anti-glare interference, specifically shown in follow aspects:

(1) Installed collimated radiation channel and filtered light. Infrared light in oblique direction could be filtered greatly while transmissivity in horizontal direction could be kept. Infrared light of sunlight could be filtered and reduced in maximum extent;

(2) Normalized light intensity signal through transference of modules, transferred "0" status of each infrared receiving tube into 0 and "1" into 0xFF;

(3) CPU kept collecting light intensity signal of infrared receiving tube, determined final area value and used it as evidence for touching and calculating coordinate of touching point;

(4) When user lifted his or her hand, CPU collected light intensity signal in 0 and 1 status of receiving tube, determined area value and used it as evidence for next touching point. Through actual calculation, it was found that after installing collimated radiation channel, touch screen could keep working even in sunlight of 7500 lux. It improved almost three times compared with former infrared touch screen which could only keep working in sunlight of 3500 lux.

CONCLUSION

Touch screen has occupied a main position in application of modern technological equipment. It is a kind of interactive device as a machine. How to solve bottlenecks in development and widen its application area, like extremely strict environment of aviation industry? Designing plan of new type infrared touch screen can be good reference for realizing these goals. Infrared emission circuit can effectively control brightness of emission tube; infrared receiving module can receive light intensity signal and transport it CPU for calculation, and finally final coordinate information is determined through calculation and sent to host computer. High resolution can be achieved by quantifying and classifying light intensity signal while capability of anti-glare reference can be improved by judging area value of light intensity and installing collimated radiation channel. At the end, multi-touch controlling can be realized through orderly recording coordinate location information of touching point, deleting useless ones and considering order of touching points. Our next goals are realizing this function on bigger touch screen and further improving capability of anti-reference. It is believed that in near future, better infrared touch screen which has more functions and provides more conveniences for people will appear.

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