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Infrared Touch Screen Sensor

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Abstract: Demand of touch screen technology is increasing day by day. This article describes one of the touch screen technology which is infrared touch screen. This technology works on basic principle of detecting an obstacle through IR. A matrix of scan lines are made through IR emitting and receiving transducers. When an obstacle is observed, it cuts the scan lines and X and Y coordinates are noted.
Index Terms: Retro-reflective tape, photo-transistor, indium tin oxide, touch technology, shadow sense technology, infrared acrylic projection.

I. INTRODUCTION

TOUCH screen technology today is growing at a rapid pace, this is the reason why the number of transistors are increasing day by day on a given chip. Increased number of transistors allows more number of functions for a given device. Now, most commonly used device is a mobile phone, which has become the most basic necessity of life. The principle user interface of mobile is touch screen.
There are various types of touch screen which are briefly explained as follows:

A. Resistive

Resistive is one of the major touch screen technologies. Resistive technology popularly supports usability, stability and low cost. Resistive technology has many applications such as camcorder, Personal Computers, Navigation devices, smartphones, etc. Resistive touc screen sensor is made up of multiple layers. Due to air gap present between the two glass layers its clarity and quality is reduced. [1]

B. Capacitive

It is generally suitable for large size monitors. A transparent sheet of Indium Tin Oxide is applied over the screen. Hence light transmitted is more as compared to resistive. Surface capacitive is structurally tough. it does not get affected by moist, dust, or grease. It has high resolution and high response time.[1]

C. Surface Acoustic

It consists of only one glass sheet. It has transmitting and receiving transducers with multiple reflectors. It works on ultrasonic waves. It has excellent visibility because of only one glass layer and does not get affected by electrical noise.[1]

D. Infrared

IR stands for infrared. The main areas of its application are sensing and remote controls. Infrared radiations are emitted or detected by infrared sensors to sense its surroundings. The basic principal of an infrared sensor is to use an obstacle as a detector is to transmit an infrared signal, this infrared signal reflects back from the surface of an object and the reflected signal is received at the infrared receiver.
Infrared lights are emitted by the infrared imaging sensors. There are two types: basic infrared and infrared optical imaging sensor. The former uses Light Emitting Diode (LED) and the latter uses retro-reflective tape.

II. INFRARED TOUCH SCREEN

Infrared light is emitted by the infrared imaging transducer. Between the two types; the basic infrared sensors consist of LEDs and phototransistors. When the LEDs are turned ON, the phototransistors located opposite to them receive the light and are turned ON. If the infrared light is blocked, the phototransistor will remain OFF.

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Infrared lights are emitted by the infrared imaging sensors. These lights are reflected by the retro-reflective tapes and are received by the sensors. When the touch screen is touched, the light emitted by the sensors does not reach the reflective tapes and hence is not reflected. This will form the shadow at the touched point and angle is measured between the sensors and shadow point. Shadow sense technology is explained below:

A. Shadow-sense technology

Shadow sense touch is based upon the precise and accurate detection of objects shadow as it enters the sensor field view. When an object is placed on the touch screen, the object's position is detected or calculated by taking the ratio of fully illuminated condition to shadowed state of the screen. When a finger is placed on the screen, various shadows are casted on the screen field. We can see that in the figure 1 shown below. The angle of shadow ray is calculated by the shadow sensors. Them the on-board processor calculates the point of interference of these multiple shadows and detects the point of touch.

B. Infrared acrylic projection

In figure 3 we can see that a translucent acrylic sheet is used as a projector screen behind which the projector is set. The infrared light is then made to fall on the acrylic sheet from its edges. The rays follow total internal reflection inside the sheet.
An infrared camera is set up behind the screen to observe the infrared rays which reflects from the sheet. When an object touches the sheet, it gets deformed and the infrared rays gets reflected back to the camera. There are two ways to illuminate the sheet: Frustrated total internal reflection, Diffused surface illumination. Both the ways are explained below: In Diffused Illumination, the illumination is done from either side of the screen. When objt touches the surface, it reflects more light than th infrared diffser in case of rear diffusion ilumination. But in case of front diffusion ilumination, the light is incident on the front such that a shadow is created when object touches the screen. That shadow is then identified by camera as object.

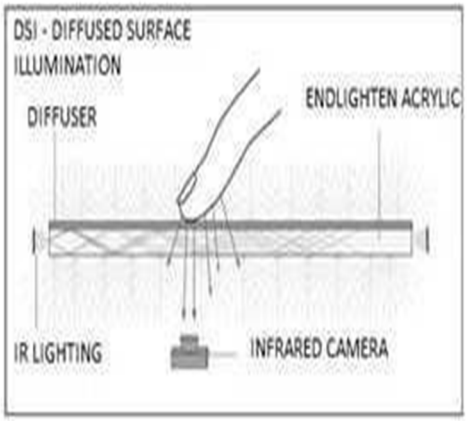


Fig. 1. Diffused surface illumination

Frustrated Total Internal Reflection is differences in the refractive indexes of adjacent materials. When a beam light passes from one material to another with a higher refractive index at an angle of incidence greater than a specific angle, this specific angle is described by Snell's law(The relationship describing how light bends at the interface of two media.), then no refraction occurs in the material, and light is reflected. In this way, infrared light which is trapped in an acrylic overlay, is scattered at the point of a touch, and this scattered light is then sensed by camera-based imaging.[9]

C. Infrared matrix based touchscreens

The basic principal behind the IR Matrix Based Touchscreen is obstacle between the invisible light path from Infrared Emitting Diode (IRED) to the phototransistor. Whenever an object comes between the light path it causes reduction in current which flows

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through the phototransistor. This causes the phototransistor to turn off and the corresponding x and y coordinates are easily obtained from this information. [2]

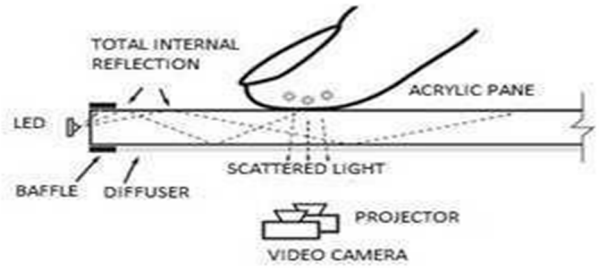


Fig.2.Topviewofinfraredacrylicprojectiontouchsensor[10]

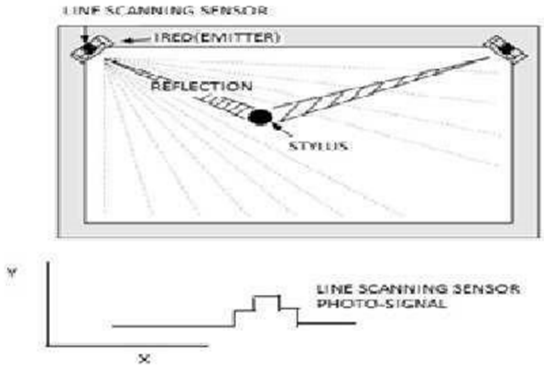


Fig. 3. IR Matrix Based Touch Screen

D. Camera based Touchscreens

In this technology, there are two line scanning sensors mounted on the top left and right corners of the screen bezel(refer figure 6). The screen is illuminated by the invisible light with the help of Infrared Emitting Diodes(IREDs) positioned along side of the light scanner. These IREDs are optically isolated to avoid crosstalk. When an object is placed on the screen, there is rise in signal of the relevant detector cells. The position of the object is computed by triangulation algorithm. More over it also tells the exact size of the object placed. [4]

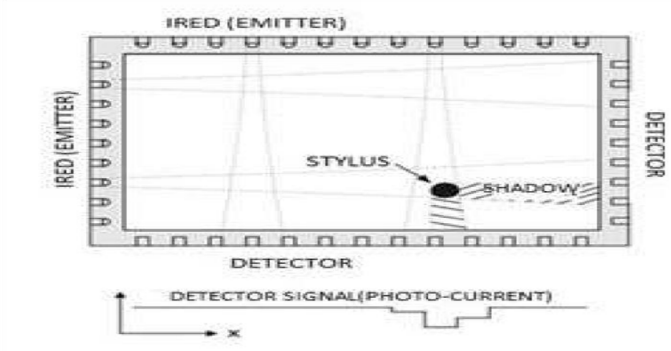


Fig. 4. Reflection type principle of camera based technology

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E. Projector based touchscreens

This is another type of technology which uses the basic concept of Infrared touchscreen. In this technology, the visible image is projected from backside onto a diffused screen. There are 1 or more IR cameras behind the screen to detect the reflected IR image of the illuminated screen. The screen is illuminated by using IREDs. When an object is placed on screen, IR image is reflected and the camera detects the location of object. [5]

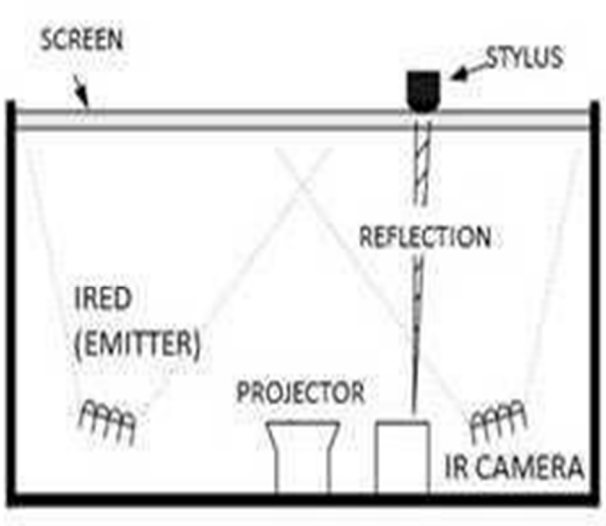


Fig. 5. Reflection type principle of camera based technology

III. COMPONENTS

Other components mentioned in the paper while explanation or working:

A. Phototransistor

Basically, phototransistors are either three terminal device (collector, base, emitter) or two terminal device (collector and emitter). It is a light sensitive device. When light is incident on the base terminal of the phototransistor the current flows through the collector. This tells that the phototransistor is ON.

Phototransistors can either be used in switching mode or active mode. In touch screen technology phototransistors are generally used in switching mode i.e. ON or OFF (same as digital output high or low).

Active mode: Vcc >RL X IC
Switching mode: Vcc <RL X IC

Where,
RL = Load resistor (Re or Rc in figures below)
IC = Maximum current Vcc = Supply voltage

Phototransistor can be configured in two ways viz. common emitter configuration and common collector configuration. The difference between these two configurations is in common emitter configuration the output is taken from collector and in common collector configuration the output is taken from emitter, this can be seen in the figures below.

B. IR LED

Typical leds have wavelength from 400nm to 650nm. IR leds have wavelength above 830nm which is invisible to human eye. these leds are typically used to detect the motion the object in dark which a human eye or a camera cannot do. Now a days they are also being used in touch screen technology. Most commonly used IR led in touch screen technology is SFH 4650.

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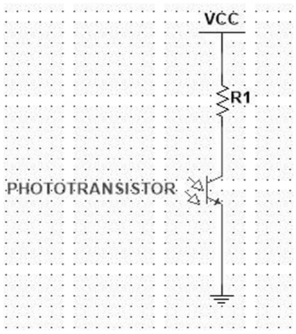


Fig. 6. NPN Silicon Phototransistot in common emmiter configuration

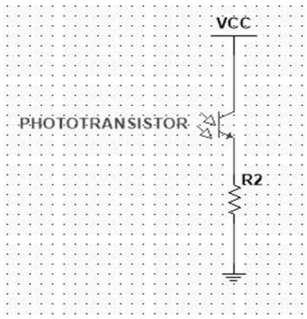


Fig. 7. NPN Silicon Phototransistot in common collector configuration

IV. CONCLUSION

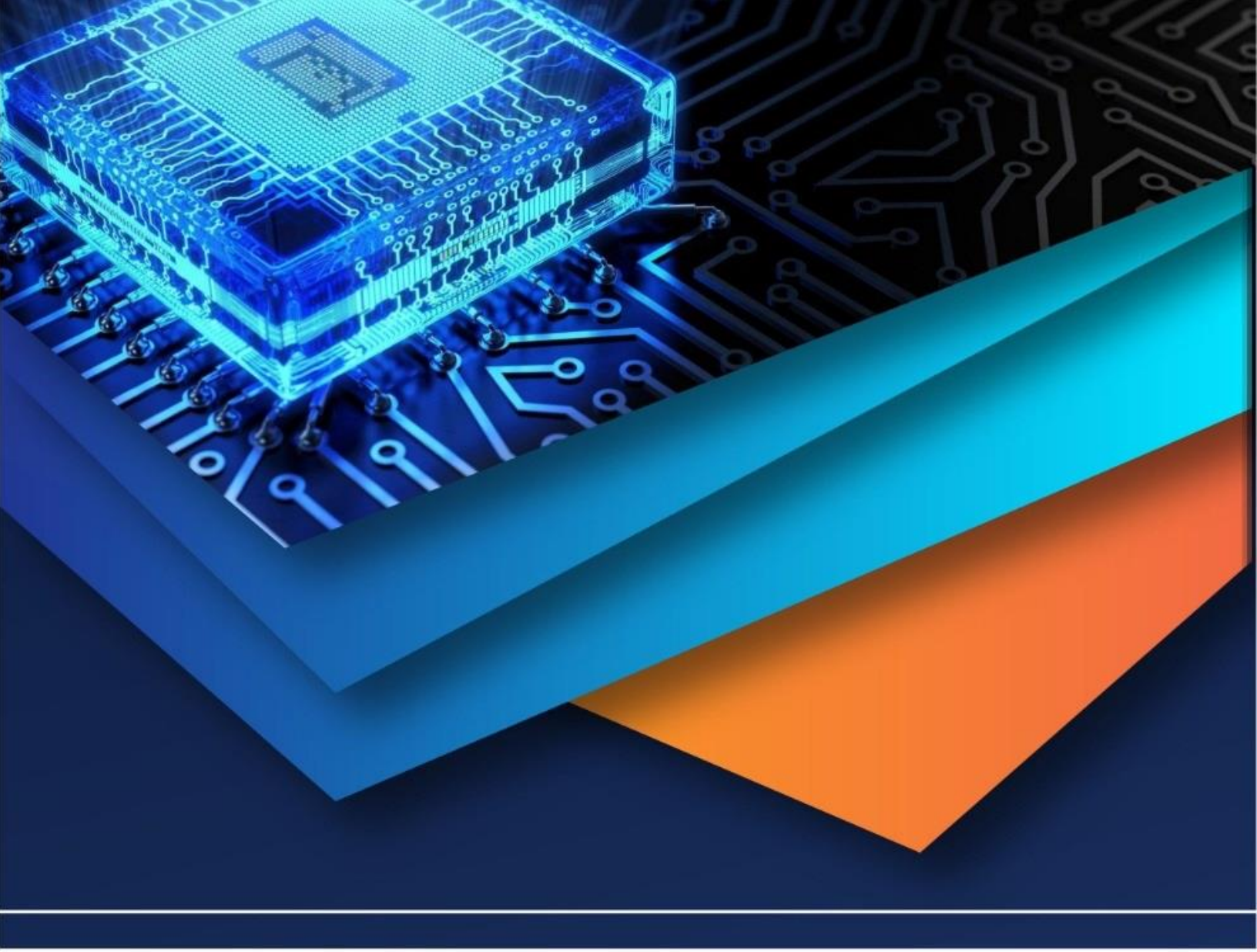
Thus, taking into consideration the increased use of touch screen technology, study of infrared touch screen sensors was done. The paper covers wide range of types of infrared touch screen sensors. The working of each technology is mentioned along with specific diagrams for better understanding. We can see that IR sensors in general have a wide area of applications from motion detection to advance touch screen. When compared to other types of touchscreen technology, infrared typically offers the highest image clarity as well as light transmission. This makes it particularly beneficial when used to produce large touchscreen displays. They also boast an exceptional level of strength and durability. Infrared touchscreen devices are protected against scratches, fingerprints and other forms of minor damage.

Hence, even though new technologies and new touch screen sensors are being invented, IR touch screen sensors will always be one of the important technology in the field of touch screens.

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