Interactive Infrared Touch Screen Bezel

Rishiraj A. Manwatkar, Saurabh S. Agrawal, Vaibhav K. Shivale

Abstract: Infrared technology relies on the interruption of an infrared light grid in front of the display screen. This technology has apparent advantages in the large-sized applications, it is simple, low cost and highly feasible. In order to obtain a more cost effective touch screen for the average consumer's personal use, a new design for an infrared LED touch screen bezel has been designed by utilizing infrared LEDs as well as photo transistors, both of which are embedded in a bezel which is comprised of PCBs on which these optoelectronics are mounted around the glass slab which allows the infrared beams to pass through. Upon touching the screen, one or more of the beams are obstructed resulting in an X and Y coordinates being sent to the MCU to process and indicate the exact touch point on the display unit.

Keywords: ATmega32, Demultiplexers, Embedded System, Infrared, Multiplexers, Touch screens

I. INTRODUCTION

Touch screen is an electronic pointing device which can detect the presence and location of a touch within the display area. Touch screens as a popular user interface have been becoming more and more common. Their applications span from public information systems to customer self-service terminals. Thus, as a logical step, more and more devices today feature this kind of user interface, e.g. bank automatic teller machines (ATMs), information kiosks, personal digital assistants (PDAs), mobile phones and PC displays.

We can say that touch screen has two common attributes. First, it enables one to interact directly with what is displayed, rather than indirectly with a pointer controlled by a mouse or touchpad. Secondly, it lets one do so without requiring any intermediate device that would need to be held in the hand.

Rishiraj Avinash Manwatkar is an Application Developer at iNautix Technologies- a BNY Mellon company manwatkar.r@gmail.com.
Saurabh S. Agrawal saurabh.sa27@gmail.com
Vaibhav K. Shivale vaibhavshivale91@gmail.com

II. LITERATURE SURVEY

Most commonly there are only two types of touch screens are used in our day to day applications as mentioned above. Before moving directly to infrared touch screen it is advisable to know following types of touch screens that are used in our day to day applications.

1) Resistive Touch Screen:

A resistive touch screen panel comprises of several layers, the most important of which are two thin, transparent and electrically-resistive layers separated by a thin space. These layers face each other, with a thin gap in between. One resistive layer is a coating on the underside of the top surface of the screen. Beneath that layer is a similar resistive on top of its substrate.

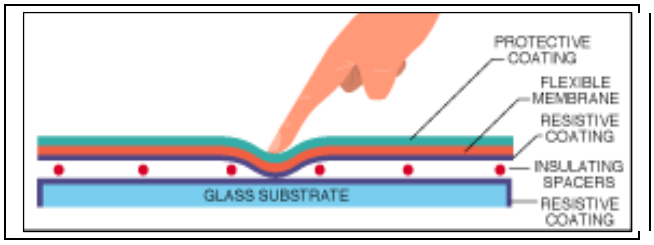


Fig. 1: Resistive touch screen

When objects, such as fingertip or stylus tip press down on the outer surface, two layers touch each other to become connected at that point. That panel then behaves as a pair of voltage dividers, one axis at a time.

2) Capacitive Touch Screen:

A capacitive touch screen panel consists of an insulator such as glass, coated with a transparent conductor such as 'Indium tin oxide'.

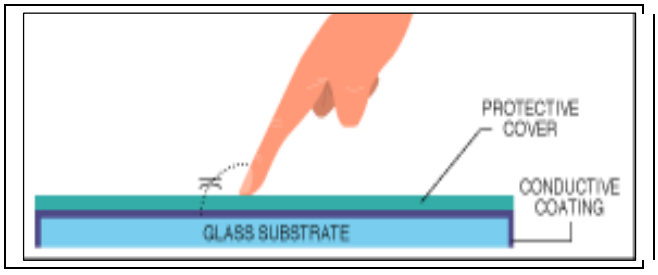


Fig. 2: Capacitive touch screen

We know human body is a very good electrical conductor, touching the surface of the screen results in a distortion of the screen's electrostatic field, measurable enough as a change in capacitance.

Different technologies are used to determine the location of touch. This paper explains one such type of touch screen- infrared touch screen.

3) Infrared Touch Screen:

This technology uses infrared emitter- collector pairs to project an invisible grid of light. An infrared touch screen is made up of an array of infrared emitters (IRLEDs) and infrared collectors (photo-transistors). At one end, an array of Photo transistors is connected and at the other end, IRLEDs are connected in another array.

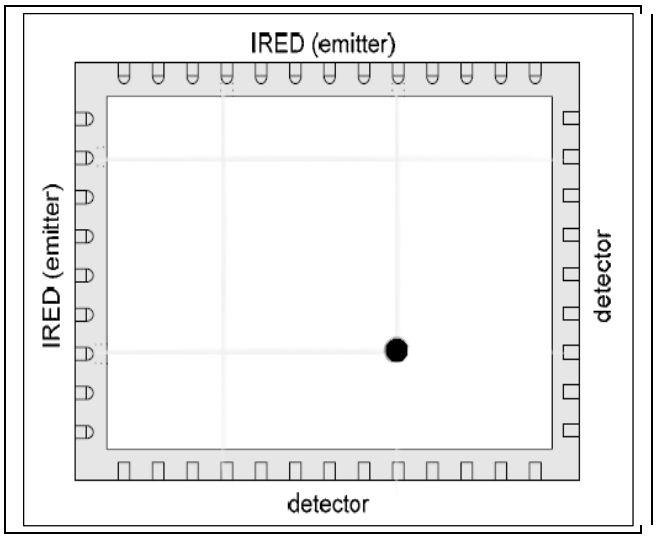


Fig. 3: Infrared touch screen

Infrared rays are continuously emitted on the photo transistors at the receiver end from the transmitter end. Infrared beams cross each other in vertical & horizontal patterns. As any touch will interrupt the path of the rays to receiver, the output of the receiver gives a certain amount of voltage change which is processed by MCU to determine the respective coordinates. These coordinates are nothing but the location of the touch.

III. SYSTEM DEVELOPMENT

System development section of this paper explains every possible step that needs to be performed during the development of the bezel. For the sake of simplicity this section is further stratified into several sub sections of which A) explains the system overview and block diagram, B) explains the selection criteria, C) explains the transmitter unit, D) explains the receiver unit, E) explains the serial communication, F) explains the system flowchart.

A) Block Diagram:

Figure 4 shows basic block diagram of the infrared touch screen bezel. As shown in the figure, arrays of infrared LEDs are placed on the two adjacent sides of the bezel, and on the opposite side are placed the arrays of photo transistors.

As the size of the screen is large enough to cause the beam from the infrared LED to disperse before it finally reaches to the respective photo transistor, a technique of grouping is used in which only one group is on and rest are off at any given period of time. This technique is incorporated in order to reduce the effect of half power angle (Θ^{o}). On the receiver (Photo Transistors) side the respective group is only on.

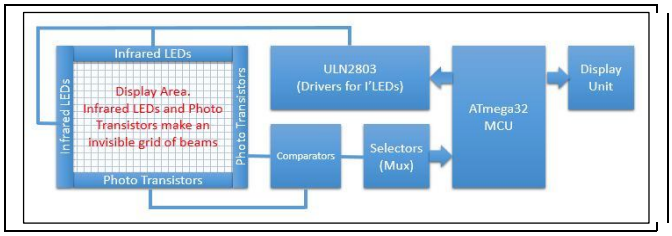


Fig. 4: System block diagram

As the MCU is inefficient to source the current enough to drive the LED, current boosting circuit is required. For current boosting purpose ULN2803 driving circuitry is used.

Figure 5 illustrates the idea about the infrared touch screen bezel. All the infrared LEDs and photo transistors are aligned such that rays that are emitted from given infrared LED must be received only by its respective photo receiver. Precaution has to be taken that the ray is focused on the respective receiver only; adjacent photo transistor should not get affected due to misalignment or any practicalities as such.

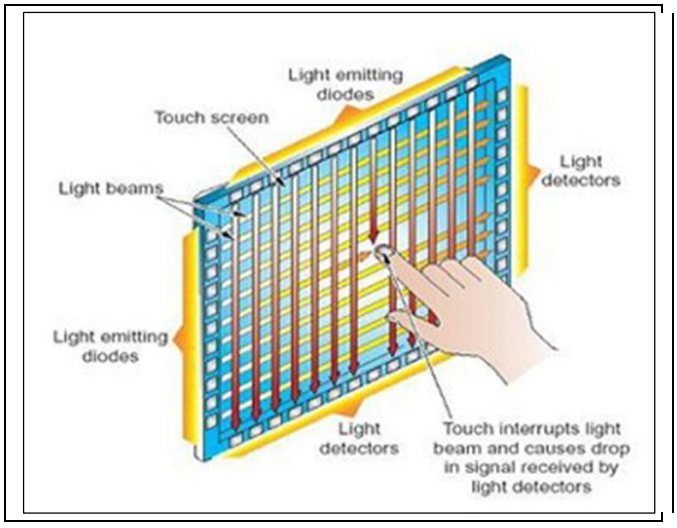


Fig. 5: IR touch screen illustration

As shown in figure 5, the beams will cross each other vertically and horizontally without interrupting their respective paths. Whenever we touch the screen within the touch area, beam gets interrupted and cannot reach to its supposed photo transistor hence change in the output signal at that photo transistor is obtained.

The change in output of the photo transistor will give us the coordinates of that particular location, which can be termed as x and y coordinates.

These signals are provided to the micro controller which processes this signal and will give the touch location at any of its port.

B) Selection Criteria:

This section guides the user about how to choose the appropriate component for development of infrared touch screen bezel.

- *Micro controller unit:*
  - It is advisable to have a micro controller unit with 8 bit architecture (this will ensure the ease of programming of the firmware).
  - 12-16Kbytes of code memory for storing the firmware.
  - For sending the co-ordinates to the display device MCU should have at least one UART port.
  - Minimum 4 I/O ports.
  - The selected MCU should be easily available in local market and should be cost effective.
  - Its development tools as well should be easily available.

- *Infrared Transmitters:*
  - Very small half power acceptance angle. (This is to ensure that no beam will collide on any other photo receiver than the supposed one).
  - Easily available in local market and cost effective

- *Infrared receiver:*
  - Very small reception angle.
  - Very small response time i.e. turn ON/OFF time
  - Easily available in local market
  - Cost effective

C) Transmitting unit:

Figure 6 shows basic block diagram of transmitting unit for the infrared touch bezel.

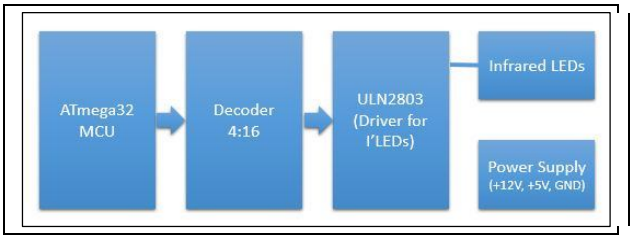


Fig. 6: Transmitter unit

Micro controller signals the 4:16 decoder (DM74154) which will select one of its 16 output lines and set it as low. Inverters are used on each line to set this output as high. Each one of these 16 lines then is connected to each Darlington pair of transistors of ULN2803. As ULN2803 has open collector logic, its output pin has been pulled up to the VCC via collector resistor. Thus required current will be flowing through the collector of the Darlington pair and is given to the infrared LED to turn it ON.

As all the infrared LEDs are grouped together, whenever we will select an appropriate select line, a particular group is turned on while all the other are remained OFF. Here the groups are time multiplexed.

D) Receiving unit:

At receiver end, all photo transistors are connected to the 12V DC via collector resistors. When the infrared rays are continuously bombarded by transmitter side on the receiver, the collector voltage level of the photo transistor is very close to 0V and whenever the path of the ray is interrupted as a result of touch, it suddenly jumps to the voltage level close to VCC.

Output of each photo transistor is compared with the threshold value such that either zero or one will appear at the output of comparator. If zero happens to occur at the output, then there is no touch occurred, and if one happens to occur, then it is predicted as touch has occurred.

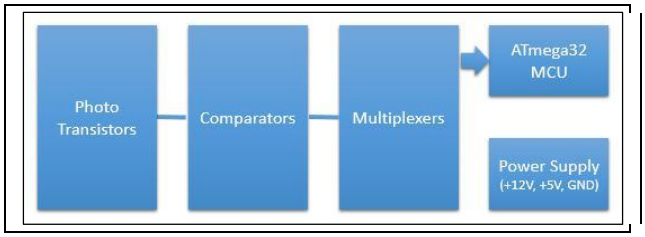


Fig. 7: Receiving unit

Photo transistors are also grouped together the same way as the infrared LEDs at the transmitter side.

Thus, when a particular group of infrared LEDs is ON at transmitting side, the output of all the photo transistors of that particular group is only checked. For this purpose, a chip select signal along with appropriate control signal i.e. select lines is provided to the multiplexer unit.

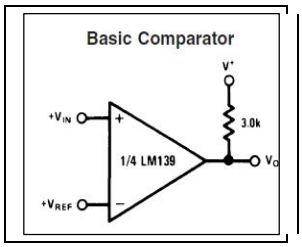


Fig. 8: Basic comparator

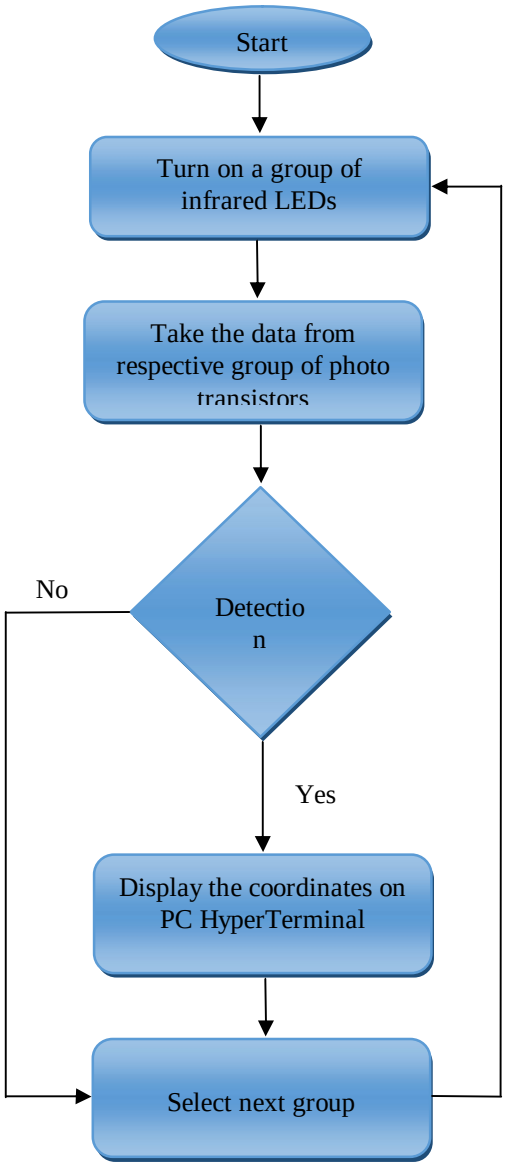
Once change in signal is observed the Micro controller will gather the output of multiplexer and will process it further to give respective output.

This change in signal will help Micro controller to detect the x & y coordinates of the location where touch is sensed. We can display these coordinates on the Hyper Terminal of the computer using UART serial communication.

E) Serial communication:

AVR based MCUs have a built-in minimum one USART (Universal Synchronous Asynchronous Receiver – Transmitter) which can be programmed to transfer and receive data through serial communication with the COM port of the PC. To allow compatibility for communication between PC and Micro controller, RS232 interfacing standard is used.

F)System Flowchart:



IV. RESULT ANALYSIS

For the infrared touch screen bezel, we can obtain X and Y coordinates by touching the glass slab. This will interrupt the path as said earlier and will give the respective coordinates.

These coordinates are displayed on the PC Hyper Terminal as (x, y).

V. FUTURE SCOPE

Future scope section covers the future applications of infrared touch screen bezel.

A) Restaurant tables:

It would be really amazing if we could replace normal, boring, non-happening restaurant tables into entertaining touch screens that could offer customers a menu card on the screen and select their orders from table itself, touch screens that could offer customers to play games until their order is served.

This is depicted in following picture.

Fig. 10: Restaurant tables with touch screens

Restaurant tables are comparatively big in size and neither does menu card require any high resolution display, so it is quite efficient to incorporate infrared touch screen bezels on them as these bezels are cheap to buy, easy to install and they serve the purpose as well.

B) Classroom black boards:

Infrared touch screens can be the replacement for conventional black boards in kindergartens, primary schools, high schools, where interaction is more important than just teaching.

C) Information Kiosks:

As these infrared touch screen bezels are comparatively low resolution devices, they can be incorporated in ATM machines, check-in counters at airport, or information kiosks where screen resolution is not the prime factor.

VI. CONCLUSION

Thus the interactive infrared touch screen bezel has been developed and is working as expected.

As an extension of this project we can develop its drivers for Linux or Windows operating systems. We can attach this bezel to PC's monitor as well, so that there wouldn't be any necessity of mouse as an input device.

V. REFERENCES

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