

G-Touch: Transparent Touch Screen Using FPGA

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ABSTRACT: Touch screen technology has the potential to replace most functions of the mouse and keyboard. The touch screen interface is being used in a wide variety of applications to improve human computer interaction. It existed everywhere in our day to day life such as smart phones or different devices. However current touch systems suffer from several limitations. The present scenario highly demands an efficient inexpensive system. This paper proposes a new large multitouch system which is of low entry cost. A G-Touch or Glass Touch can convert a transparent glass into a touch pad. This glass touch screen technology is the perfect solution to make our projection screens interactive touch screens. Main challenge behind the prototype system is the proper placement of every component in order to give perfect access.

KEYWORDS: Touch screen, IR Camera, Projector system, Laser, FPGA

I. INRODUCTION

Our personal life is highly dependent on the technology that people have developed. Technology has advanced especially in the field of HCI(Human Computer Interaction) over past few decades and it has changed the way we purchase products , the way we live , the way we communicate , the way we travel , the way we learn and so many changes have been brought about by these continuous technological advancements. HCI reduces the barrier between human and computer by user interaction. One of the most famous interaction is touch sense technology. The main advantage of touch screen technology is how easy it is to use. Touch technology provides a fast and intuitive interface for users and simplify customer interactions. Users do not have to know how to use a computer and can simply touch the display to make selections. No keyboard is required, saving valuable space.

Touch screens are fast becoming the wave of the future, and the momentum doesn't show any signs of slowing down. As technology continue to push for the most user-friendly interfaces, your fingers are quickly becoming the most powerful tools around you. There are various methods to implement a touch system, which are normally categorized into two types: Sensor-based and Vision-based. The different touch technologies are Wire Resistive, Surface Capacitive, Projected Capacitive, SAW (Surface Acoustic Wave). In the early days, resistive touch method is frequently used. This method required minimum space between the screen and sensor. When user applies pressure on the surface, touch coordinate will be detected using different signals. This method is able to, detect inputs from any object, but the touch sensitivity is poor and the touch screen has low resolution. It is mainly because the sensor is placed above the screen. Recently, capacitive touch sensor has replaced resistive touch sensor as the most frequently used touch sensing technology, as seen on different touch devices. The touch surface is coated with conductive material. When a small voltage is applied to this layer via some conductive object such as fingers, the coordinate of the object can be detected. It is able to detect multiple touch points, but it greatly depends on the conductive material. Yet, this method still possesses many restrictions on touching. Non-conductive object will not trigger the touch action. On the other hand, there are different methods in vision-based touch system too.

Existing touch systems mostly focused on small devices such as smart-phones and portable devices. There are large multi-touch systems available such as Microsoft Surface but it is extremely expensive. This system proposes and develops a new surface multi-touch system using low cost camera. This system requires only a single camera for the

touch detection without any support of other devices. The system is very robust and is not affected by illuminations of surrounding environment.

II. LITERATURE SURVEY

Although touch screen technology has minimized the human communication interface between human and machine closer than ever, the capability of detecting only a single point of contact is not convenient for practical applications. The more direct way is to support detecting multiple points of contact in multitouch screen technology.

First multitouch pad was proposed by Lee, Buxton, and Smith in 1985. It used digitizer as its main component and it composed of an array of capacitive proximity sensors where the finger and sensor act as two plates of capacitors. Vision based systems are classified as direct systems in which the camera is aimed at user's hand whereas in indirect system the camera is aimed at touch surface that produces a change in the image when touched by a finger or object. The presentation system is actuated on screen by a laser pointer. Laser spot on the screen is captured by a RGB webcam with a red filter mounted, and its location is identified at the blue layer of each captured frame by estimating the mean position of pixels whose intensity is above a given threshold value.

Resistive touch is the most widely used touch technology today. A resistive touch screen monitor is composed of a glass panel and a film screen, each covered with a thin metallic layer, separated by a narrow gap. When a user touches the screen, the two metallic layers make contact, resulting in electrical flow. The point of contact is detected by this change in voltage. Basic disadvantage will include limited durability for large screens and its maintenance.

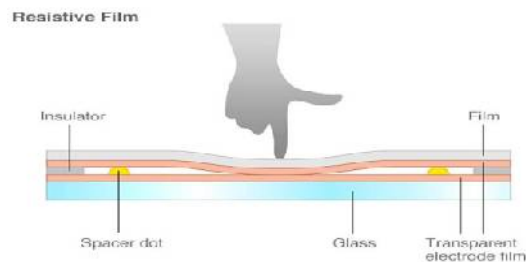


Fig.1. Resistive touch

In capacitive touch screen monitor, a transparent electrode layer is placed on top of a glass panel, and covered by a protective cover. When an exposed finger touches the monitor screen, it reacts to the static electrical capacity of the human body; some of the electrical charge transfers from the screen to the user. This decrease in capacitance is detected by sensors located at the four corners of the screen, allowing the controller to determine the touch point.

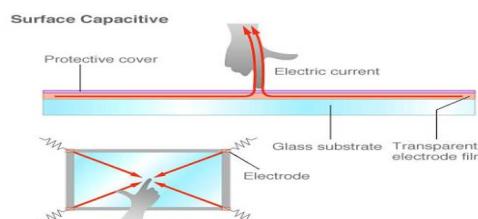


Fig.2. Capacitive touch

III. RESEARCH METHODOLOGY

The current technology suffers from certain limitations such as high cost, size etc. Analyses have shown that resistive touch screen does not work properly whereas capacitive touch screen with its high cost on production is an

added disadvantage. Our present system converts any screen into a reliable touch screen cost effectively. Here we can setup a screen of any size. In this project we use an acrylic sheet as touch pad. But with sufficient modification we can extend this facility to any surface. A glass touch screen is an input device normally layered on the top of an electronic virtual display of an information processing system. It is able to provide complete product line, it is ideally suited for both automobile market and popular consumer market applications such as smart phones, digital photo frames, and tablet PCs. The development of interactive touch products not only makes product operation easier, but also emphasizes the feeling of interactive communication for the consumers.

IV. SYSTEM ARCHITECTURE

Proposed system is mainly wireless system, in this technique, the surface is illuminated by single or multiple lasers. The laser plane of light is proximally positioned to the touch surface. When a finger touches the light plane, the object lights up and viewed by an infrared camera focused on to the surface. The camera extracts the touch position and sends to the processing unit where the processing is done using software and touch is generated on the surface. Touch pad consists of a plane transparent glass screen. The screen is coated by an acrylic sheet (clear plastic) behind. The acrylic sheet is used for achieving more clarity for image. A Laser is used for illumination. The term laser originated as an acronym for “light amplification by stimulated emission of radiation”. A laser differs from other sources of light in that it emits light coherently. Major concern about all touch sensor is the response time; the time between when the screen is touched and when the system recognizes that there is a finger in contact. The camera connected with high speed FPGA kit continuously scans against a background, which detects our finger when it sees red color due to plane laser light. As a finger touched on the surface, it was noticed that there was a delay time for the finger to reach a maximum brightness state. To minimize this effect, more than 1 or 2 laser module can be used in the system.

A field-programmable gate array (FPGA) is an integrated circuit designed to be configured by a customer or a designer after manufacturing, hence “field-programmable”. FPGA captures the screen through the camera and detects the position where the red appears. The implementation of image capturing and processing are all done in FPGA using VHDL algorithm. Mimas is an easy to use FPGA Development board featuring Xilinx Spartan-6 FPGA. Mimas is specially designed for experimenting and learning system design with FPGAs. This development board features Xilinx XC6SLX9 TQG144 FPGA with maximum 70 user I/Os. The USB 2.0 interface provides fast and easy configuration download to the on-board SPI flash. You don’t need a programmer or special downloader cable to download the bit stream to the board. The standard FPGA design flow starts with design entry using schematics or a hardware description language (HDL), such as Verilog HDL or VHDL. In this step, you can create a digital circuit that is implemented inside the FPGA. The flow then proceeds through compilation, simulation, programming, and verification in the FPGA hardware.

The OV7670 CAMERACHIP is a low voltage CMOS image sensor that provides the full functionality of a single-chip VGA camera and image processor in a small foot print package. The camera is used to capture the image of fingers and touch pad in real time. Projector is a highly versatile tool for presentation. Here we use a projector to project the computer screen to the touch pad. For best results, choose a projector that provides the key features that support the primary activity of your projector. Most projectors use high-intensity discharge (HID) lamps as a light source.

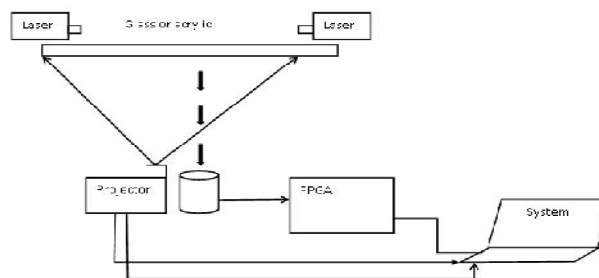


Fig.3. System Architecture

V. PROPOSED PLAN OF WORK

G-touch utilizes mainly an FPGA as the core of its functioning. Glass screen coated with acrylic is illuminated with single/multiple lasers. Information from PC is projected to the screen using a projector which is connected to the VGA port of the PC. Camera will be continuously monitoring the screen. When finger is touched on the screen, light intensity on the image portion on screen varies. If this variation is above a particular threshold value and threshold time, touch is identified. Camera gives a clear color image to FPGA, which identifies the pixel coordinates of touched position using variations in light intensity.

FPGA uses UART module to interface with PC. Receiver in the UART module sends input to UART controller, thereby it can give a flag indicator to the camera. Camera uses this data as a start of capturing images from screen. XY positions of touched part is identified by camera using its inputs like VSYNC, HREF, PCLOCK and Y channel. Controller receives this coordinate values and translates it into corresponding ASCII codes and provides to UART transmitter. Transmitter also receives input from Baud generator module to synchronize the speed of FPGA with that of UART module. FPGA implements all its functions using logic gates present in it. Output of FPGA is given to the operating system of PC for processing the image and creates a touch in the glass screen. Implementation of circuits and their design using FPGA is much easier than using any other integrated circuits.

VI. CONCLUSION

Although there are various methods of multi-touch systems proposed, it is difficult to be used as applications because of high complexity of structure, high cost, and low display capability. To achieve high applicability and complement these disadvantages, the proposed system primarily focused on the study of work done in the area of hand gesture recognition using single camera, mini projection system and partial hand wearable system, which converts any flat surface into touch screen system. User can easily access wall, desk, canvas, etc. surface as a computer display system and control all the computation activity of the computer.

G-touch or touch screen technology reduces the human efforts. Touching a visual display of choices require little thinking and is a form of direct manipulation that is easy to learn. These are the fastest pointing devices and have easier hand eye coordination than keyboards. Glass touch screens are durable in public access and in high volume usage.

We have tested the software and hardware for our touch application and it is successful. We can find many applications with this project. The system we have developed is relatively economical. We can add some features in our future developments in order to make the system more efficient, like developing a stylus pen to write and also to copy and paste.

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