ECE 492 - Computer Engineering Design Project

Multi-touch Table

Alix Krahn, Denis Lachance, Adam Thomson

2014

What is it?

- Interactive touchscreen to control software applications
- Supports multiple touches to allow natural manipulation and interaction

Motivation

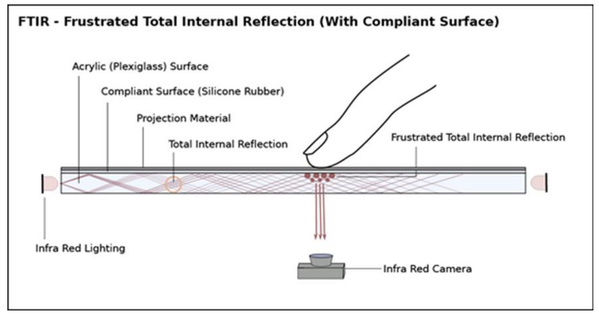
- Natural user interface for using computers
- Useful for collaboration and learning, particularly with children and people who are disabled
- Has been used for rehabilitation

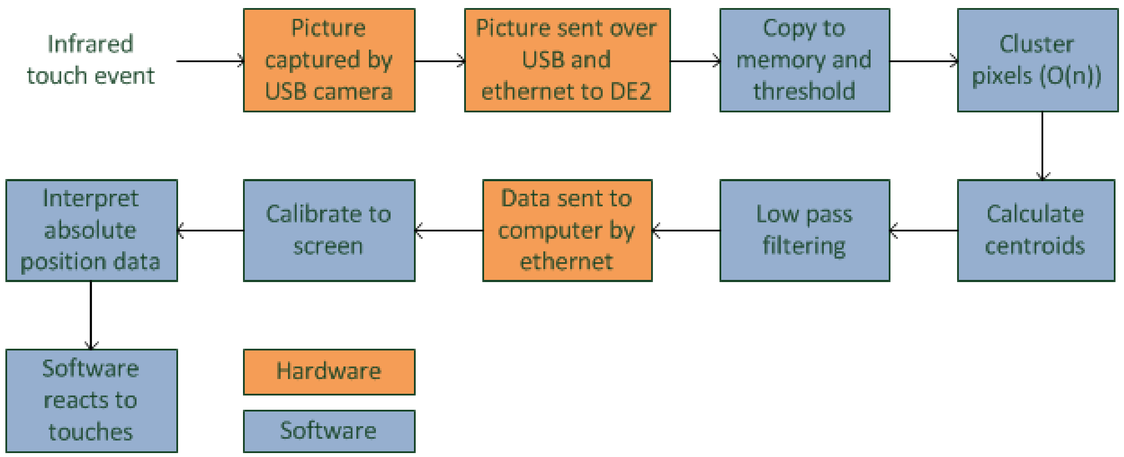
Components

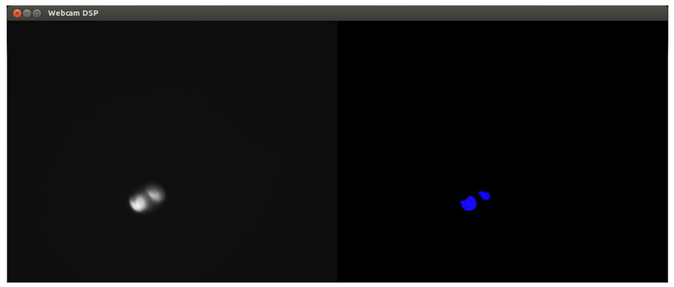
- Touch screen
  - Acrylic sheet surrounded by infrared LEDs
  - Silicone compliant surface
  - Vellum projection surface
- Camera to capture infrared touch events
- Hardware (Nios DE2 board) to process touch events
- Projector to provide image on the screen
- Computer to run application software

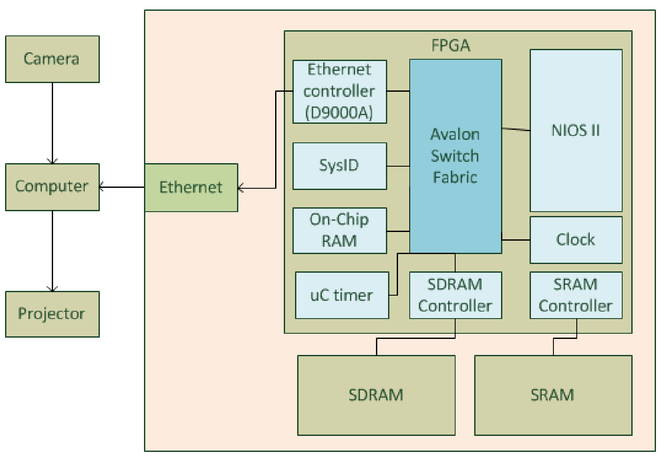
The Physics: How Touches are Detected

- Three essential layers are in the touch surface (bottom to top): acrylic sheet, compliant layer, projection surface
- Acrylic sheet surrounded by a rim of infrared LEDs directed into the acrylic sheet
- Infrared light is trapped within the acrylic surface due to critical angle
- When a touch event occurs, infrared light reflects downwards from the touch event, as critical angle changes
- Compliant surface results in better “blobs”
- A webcam with a filter to pass infrared light is directly below the screen, and captures images of infrared light containing the touch events









The Processing

- Images captured by the USB are in raw Bayer format, and sent to the DE2 board
- Infrared touch events appear as white “blobs” in the picture
- On board, the software processes each image pixel-by-pixel:
  - Thresholds each pixel – a pixel with an intensity above a certain amount is considered to be “1” and contain part of a touch
  - Clusters groups of “1”s together into groups, separating each area of the image that contains a distinct touch event
  - Centroid of each cluster is calculated, and considered to be the touch point
  - Low-pass filter used to smooth the touch point as compared to the last picture frame
- Points sent to computer, where they are calibrated and used
- Gestures are considered by difference in position of touch events from frame-to-frame, are processed on the computer

The Interfaces

- USB was used between the camera and the computer
- Ethernet was used between the board and the computer
- VGA was used between the computer and the projector

Challenges

- USB controller and driver were written from scratch, as no found USB controller/driver worked
- USB is incredibly complicated to implement
- USB data speed is very low – only 1.5MB/s – which allows for only low quality pictures to be used
- USB isochronous interface very difficult to get functional

UNIVERSITY OF ALBERTA

Department of Electrical & Computer Engineering