Abbreviations

Multi-touch: An interactive technique that allows single or multiple users to control graphical displays with more than one simultaneous finger.

Multi-point: An interactive technique that makes use of points of contact rather than movement. A multi-point kiosk with buttons would be an example.

Multi-user: A multi-touch device that accepts more than one user. Larger multi-touch devices are said to be inherently multi-user.

Multi-modal: A form of interaction using multiple modes of interfacing with a system.

Tabletop Computing: Interactive computer displays that take place in the form of tabletops.

Direct manipulation: The ability to use the body itself (hands, fingers, etc) to directly manage digital workspaces.

Blob tracking: Assigning each blob an ID (identifier). Each frame we try to determine which blob is which by comparing each with the previous frame.

Blob detection: Process of picking out bright areas of a camera image and somehow relaying them to a computer as a touch.

Tracker: The program which takes images from a camera, puts them through several filters, and finally reports the position, size, and relative movement of blobs over some protocol

TUIO: Tangible User Interface Objects - a protocol used for communicating the position, size, and relative velocity of blobs. It is built on OSC, which is built on UDP.

Touch event: A term used to describe when a system knows that an object has touched the multi-touch device.

Gesture: A physical movement that can be sensed, and often an action assigned to it. Some common gestures are single finger panning, and two finger zoom-pinching.

Sensor: A device that measures changes in an environment.

ZUI: Zoomable User Interface - a user interface in which the entire thing is zoomable. In theory this would give you infinite workspace, but memory constrictions limit this.

Touchlib: A widely used open-source tracking and event library for optical based

infrared multi-touch solutions. This is an example of a tracker.

Diffuser: Something that spreads and scatters light. A diffuser is used in various multi-touch techniques to create even lighting.

FTIR: Frustrated Total Internal Reflection - a multi-touch technique that exploits the phenomena of Total Internal Reflection. Light within a transparent channel of low refractive index will reflect internally until an object with a higher refractiveindex, such as a finger, touches or frustrates the surface thus lighting up the frustrated area.

DI: Diffused Illumination - a multi-touch technique that makes use of a diffused surface to help filter shadows (Front DI) orilluminated fingers (Rear DI) from a touch surface. Sometimes this is referred to as Direct Illumination.

LLP: Laser Light Plane - a multi-touch technique that uses a laser and line generating lens to cast a beam over a touch surface.When the beam plane is broken by an object, the area is lit up.

DSI: Diffused Surface Illumination - a multi-touch technique that uses a special acrylic Endlighten to help disperse even light supplied by edge lighting the acrylic. The effect is similar to DI.

Stereo Vision or Stereoscopic: A two camera multi-touch technique.

Zero force: Refers to the amount of force or pressure needed to trigger a touch event. In this case, 'zero' means 'little.'

Touchlib: A widely used open-source tracking and eventlibrary for optical based infrared multi-touch solutions. This is an example of a tracker.

Chapter 1

Introduction to Multi-Touch

In this chapter:

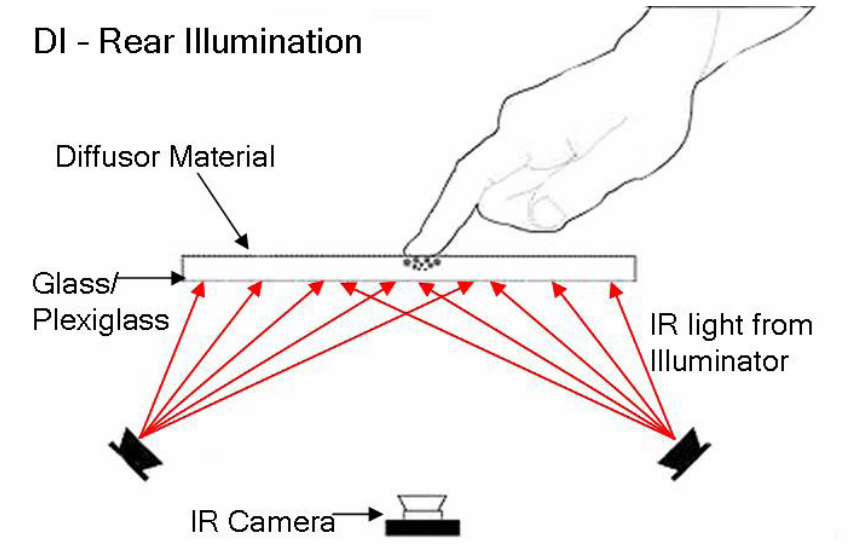
Chapter 2

Multi-Touch Technologies

In this chapter:

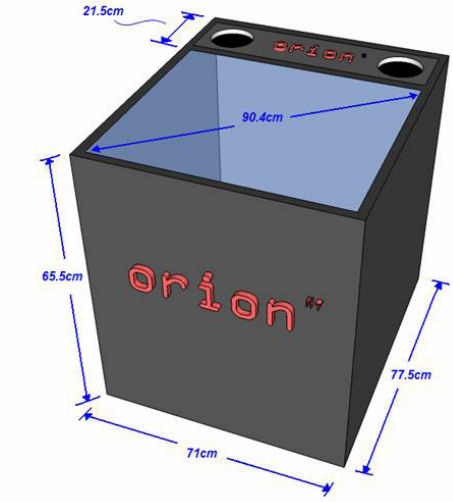
Diffused Illumination (DI)

Infrared light is shined at the screen from below the touch surface. A diffuser is placed on the bottom of the touch surface so that when an object touches the surface it reflects more light than the diffuser or objects in the background. This extra light is sensed by an infrared camera and (using tracking software) is filtered into 'blobs' which are then converted into x,y co-ordinates Below is a picture illustrating the effect of diffused illumination.



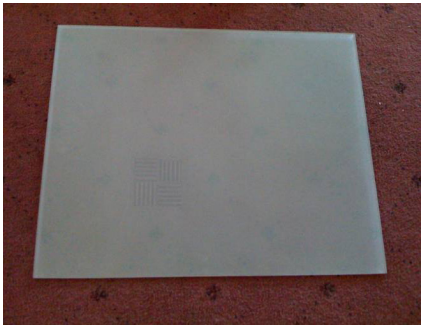
Step 1: Building the Box

The first step in making a Diffused Illumination (DI) Multi-touch table is to build the enclosure. DI setups require a closed box so that no infrared light escapes. Were light to escape, there would be no uniform infrared brightness within the box, effectively rendering the effect useless. Below is a basic 3D model created using Google SketchUp of the ORION Multi-touch Table.



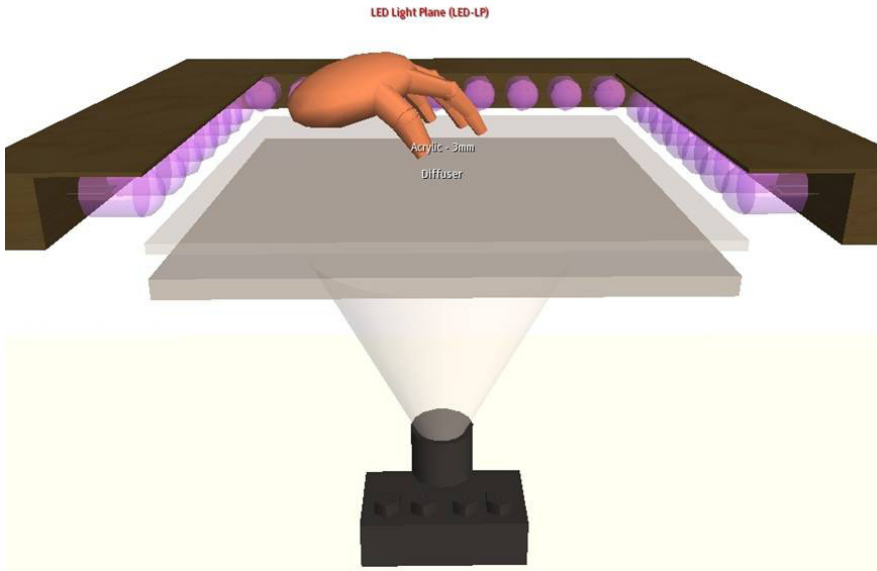
The box is built out of 12mm craft wood/medium-density fiberboard (MDF). There is a section on the top of the box so that a small mirror could be mounted to increase projection throw. This section is also designed to house some small speakers and possibly an external keyboard.

The glass sheet pictured here was later replaced with a sheet of 4mm thick glass, 71cmx56cm frosted (sandblasted) on one side for the diffuser/projection surface.



LED Light Plane (LED-LP)

LED-LP is setup the same way as an FTIR setup except that the thick acrylic that the infrared light travels through is removed and the light travels over the touch surface. This picture [Figure 1] shows the layers that are common in an LED-LP setup:



The infrared LEDs are placed around the touch surface; with all sides being surrounding preferred to get a more even distribution of light. Similar to LLP, LED-LP creates a plane of IR light that lays over the touch surface. Since the light coming from the LEDs is conical instead of a flat laser plane, the light will light up objects placed above the touch surface instead of touching it. This can be adjusted for by adjusting filter settings in the software (touchlib/tbeta) such as the threshold levels to only pick up objects that are lit up when they are very close to the touch surface. This is a problem for people starting with this type of setup and takes some patience. It is also recommended that a bezel (as can be seen in the picture above) is put over the LEDs to shield the light into more of a plane.

LED-LP is usually only recommended when working with an LCD screen as there are better methods such as Rear DI when using a projector that usually don't work with an LCD screen. Like Rear DI and LLP the touch surface need not be thick like in FTIR, but only as strong as it needs to support the forces from working on the touch surface.

Layers used are:

Touch Surface

• A strong, durable surface that can take the pressure of user interaction that is optically clear. Usually acrylic or glass.

Diffuser/Projection Layer

• If using in a projector setup, the image is stopped and displayed on the projection layer. If using in an LCD setup, the diffuser is placed below the LCD screen to evenly distribute the light from the LCD backlight.
The source of infrared light for an LED-LP setup comes from infrared LEDs that are placed around at least 2 sides of the acrylic right above the touch surface. Typically the more sides surrounded, the better the setup will be in IR prevalent lighting conditions. Refer to the LED section for more information on IR LEDs.

A computer webcam is placed on the opposite site of the touch surface so that is can see the blobs. See the camera section for more information on cameras that are commonly used.

Below are two pictures of PeauProduction's LED-LP LCD table (figure 2):