Making A Touch Table

-by The Visionariz (15th May - 25th June 2011)

Introduction

The project aims to create a touch surface and an interface for interaction. There are many ways of establishing touch capabilities.

The Transistor Switch

It works on the principle that our body is a conductor. On touching a live wire, a mild current flows through the body. This current can be amplified using a transistor, and then can be used to create a potential difference across a resistor. But this technology can only be used to create touch buttons and is highly inefficient and bulky

Resistive Touch

The **resistive system** consists of a normal glass panel that is covered with a conductive and a resistive **metallic** layer. These two layers are held apart by spacers, and a scratch-resistant layer is placed on top of the whole setup. An electrical current runs through the two layers while the monitor is operational. When a user touches the screen, the two layers make contact in that exact spot. The change in the electrical field is noted and the coordinates of the point of contact are calculated by the computer.

Capacitive Touch

In the **capacitive system**, a layer that **stores electrical charge** is placed on the glass panel of the monitor. When a user touches the monitor with his or her finger, some of the charge is transferred to the user, so the charge on the capacitive layer decreases. This decrease is measured in **circuits** located at each corner of the monitor. The computer calculates, from the relative differences in charge at each corner, exactly where the touch event took place and then relays that information to the touch-screen driver software. One advantage that the capacitive system has over the resistive system is that it transmits almost 90 percent of the light from the monitor, whereas the resistive system only transmits about 75 percent. This gives the capacitive system a much clearer picture than the resistive system.

Optical Touch Systems (Surface Wave)

In Optical touch devices a layer of light (typically infrared) is created over a glass sheet. When a finger touches the sheet light gets reflected into the glass, where lies a camera which records the position of reflected light. This position is used to determine the location of the touch point on the surface. The advantage of such a touch device over the other is that it’s cost effective when it comes to creating a large touch surface and is more sensitive to touch than the other two technologies.

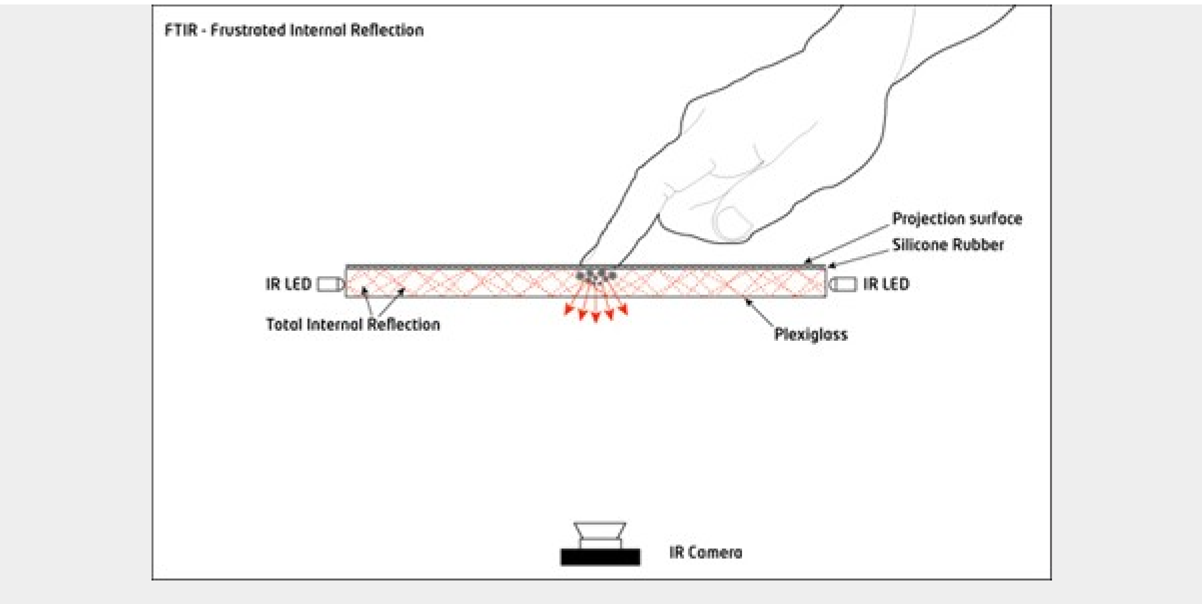
Project Theory

We plan to implement and use the Optical touch technology for a device as big as a table top. The implementation of the project lies in the method of generating a layer of infrared light over the glass sheet. This can be done in the following manner

Frustrated Total Internal Reflection (FTIR)

Infrared light is shined into the side of an acrylic panel (most often by shinning IR LEDs on the sides of the acrylic). The light is trapped inside the acrylic by internal reflection. When a finger touches the acrylic surface this light is “frustrated” causing the light to scatter downwards where it is picked up by an infrared camera.

A silicone rubber layer is often used as a “compliant surface” to help improve dragging and sensitivity of the device. When touching bare acrylic, one must press hard or have oily fingers in order to set off the FTIR effect. With a complaint surface (like silicone rubber) the sensitivity is greatly improved.



Diffused Illumination (DI)

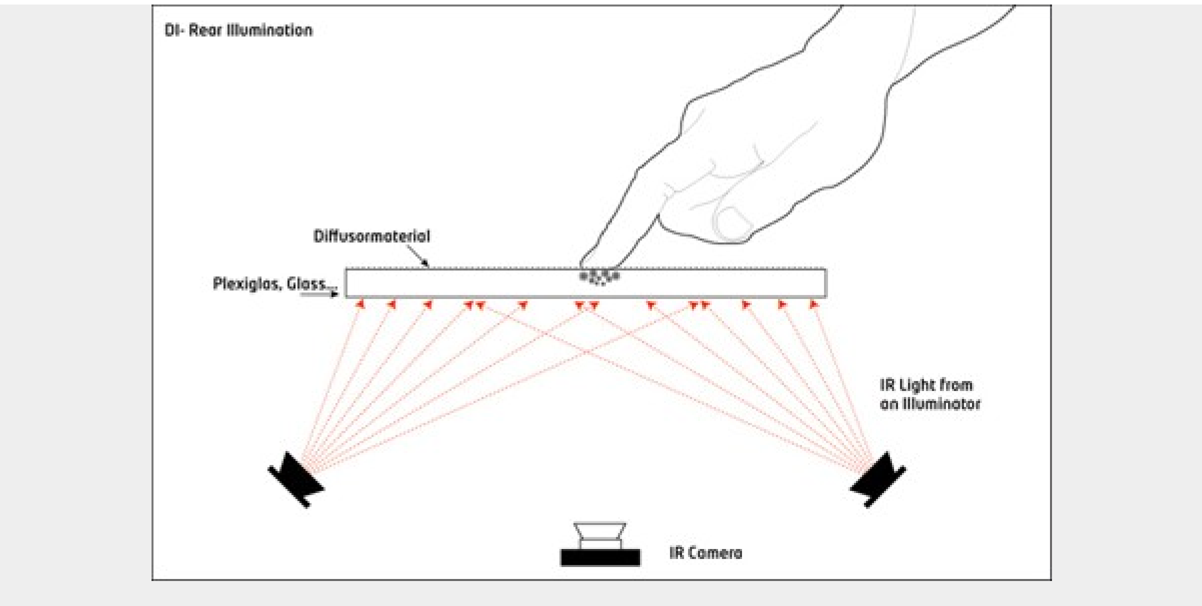
Diffused Illumination comes in two main forms. Front Diffused Illumination and Rear Diffused Illumination. Both techniques use the same basic principles.

Front DI

Infrared light (often from the ambient surroundings) is shined at the screen from above the touch surface. A [diffuser] is placed on top or on bottom of the touch surface. When an object touches the surface, a shadow is created in the position of the object. The camera senses this shadow.

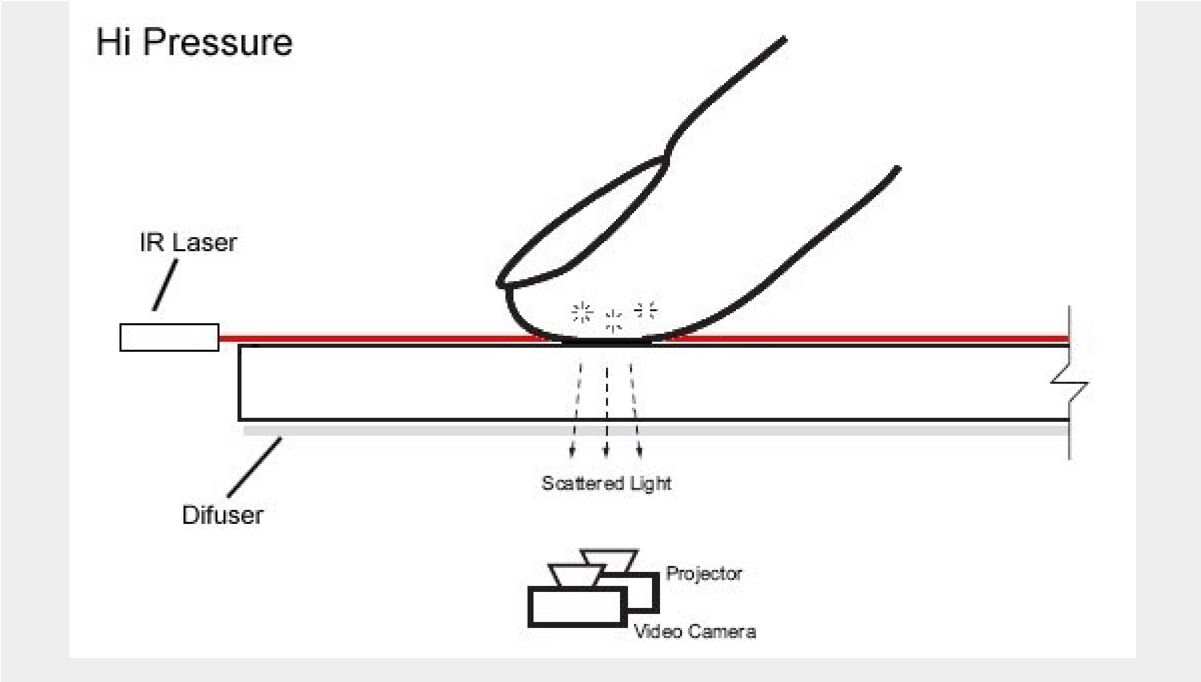
Rear DI

Infrared light is shined at the screen from below the touch surface. A diffuser is placed on top or on bottom of the touch surface. When an object touches the surface it reflects more light than the diffuser or objects in the background; the extra light is sensed by a camera. Depending on the diffuser, this method can also detect hover and objects placed on the surface.



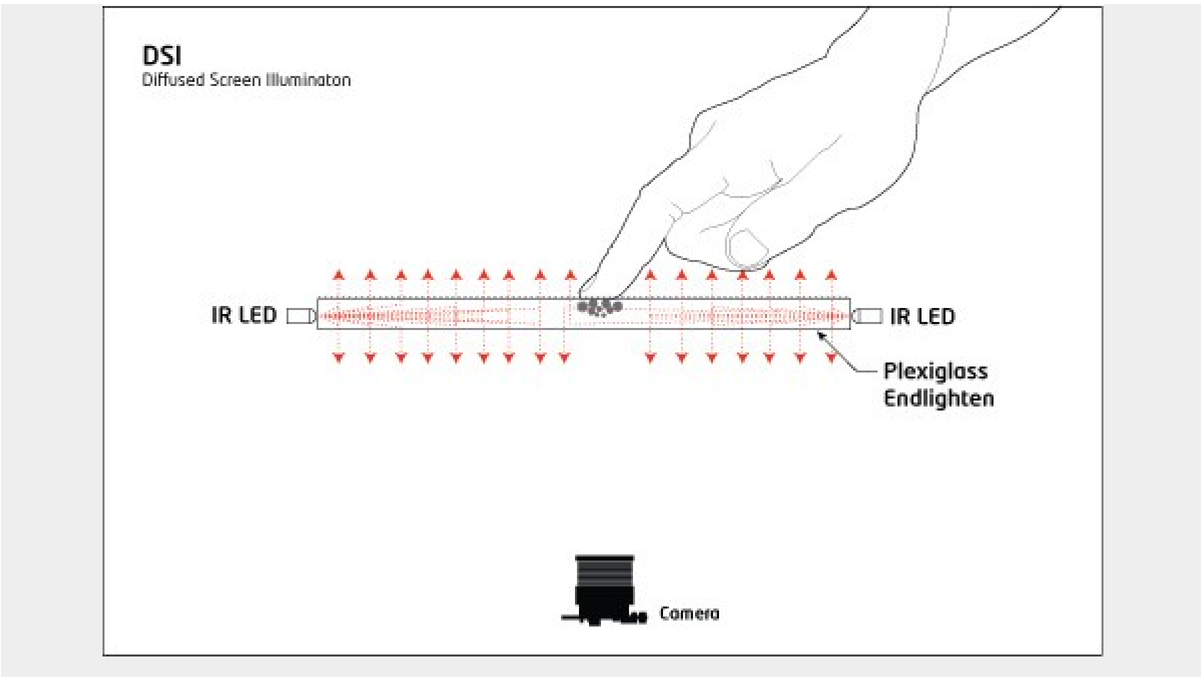
Laser Light Plane

Infrared light from a laser(s) is shined just above the surface. The laser plane of light is about 1mm thick and is positioned right above the surface, when the finger just touches it, it will hit the tip of the finger which will register as a IR blob.



Diffused Surface Illumination (DSI)

DSI uses a special acylic to distribute the IR evenly across the surface. Basically use your standard FTIR setup with an LED Frame (no compliant silicone surface needed), and just switch to a special acrylic. This acrylic uses small particles that are inside the material, acting like thousands of small mirrors. When you shine IR light into the edges of this material, the light gets redirected and spread to the surface of the acrylic. The effect is similar to DI, but with even illumination, no hotspots, and same setup process as FTIR.



Technique Comparison

Each technique has its pro and cons. But based on our situation we choose the best for us.

FTIR:

Pros:

o An enclosed box is not required
o Blobs have strong contrast
o Allows for varying blob pressure
o With a compliant surface, it can be used with something as small as a pen tip

Cons:

o Setup calls for some type of LED frame (soldering required)
o Requires a compliant surface (silicone rubber) for proper use
o Cannot recognize objects or fiducial markers
o Cannot use a glass surface

Rear DI:

Pros:

o No need for a compliant surface, just an diffuser/projection surface on top/bottom
o Can use any transparent material like glass (not just acrylic)
o No LED frame required
o No soldering (you can buy the IR-Illuminators ready to go)
o Simple setup
o Can track objects, fingers, fiducials, hovering

Cons:

o Difficult to get even illumination
o Blobs have lower contrast (harder to pick up by software)
o Greater chance of 'false blobs'
o Enclosed box is required

Front DI:

Pros:

o No need for a compliant surface, just an diffuser/projection surface on top/bottom
o Can use any transparent material like glass (not just acrylic)

o No LED frame required
o No soldering (you can buy the IR-Illuminators ready to go)
o Can track fingers and hovering
o An enclosed box is not required
o Simplest setup

Cons:

o Cannot track objects and fiducials
o Difficult to get even illumination
o Greater chance of ‘false blobs’
o Not as reliable (relies heavily on ambient lighting environment)

LLP:

Pros:

o No compliant surface (silicone)
o Can use any transparent material like glass (not just acrylic)
o No LED frame required
o An enclosed box is not required
o Simplest setup
o Could be slightly cheaper than other techniques

Cons:

o Cannot track traditional objects and fiducials
o Not truly pressure sensitive (since light intensity doesn’t change with pressure).
o Can cause occlusion if only using 1 or 2 lasers where light hitting one finger blocks another finger from receiving light.

DSI:

Pros:

o No compliant surface (silicone)
o Can easily switch back and forth between DI (DSI) and FTIR
o Can detect objects, hovering, and fiducials
o Is pressure sensitive
o No hotspots
o even finger/object illumination throughout the surface

Cons:

o Enlighten Acrylic costs more than regular acrylic (but the some of the cost can be made up since no IR illuminators are needed)
o Blobs have lower contrast (harder to pick up by software) than FTIR and LLP

Our Choice

We choose to build the project based on laser light plane because it was cost effective and did not involve buying of acrylic surfaces and sheets. Also the quality and sensitivity of touch and its responsiveness to it was better compared to other touch technologies.

Project Requirements:

Requirements

Tools

Power drill + 5mm drill
Standard size screwdriver (flathead & cross)
Small sharp knife
Scissors
Different grits of sanding paper
Wooden cubical object to wrap sanding paper around
Copper or silver polish + towel
Synthetic material saw

Building materials

Screws € 5
Glue (hotglue / white glue) € 10
Frame material (for example wood, aluminium or PVC) € 5 (depends on construction)
Connector strips € 5
Electronic wire (0,5 mm) € 5
IR-lasers with 89o line generator $11
Glass € 25
Black photo negatives free
Power source € 10
Power cable € 5
Webcam € 15
Projector € 200+
Projection material (tracing paper) € 5

Working computer
Mirror (optionally)

So basically the projector is the most expansive part of the device. You can make a multi touch display without a projector and use your monitor as an output, which is like totally not cool ;)
So for an amount of about € 350, you'll be able to build a cool multi touch display.
You could also go with a more expansive webcam, filter or projection material, for better performance, but for the proof of concept, this will do.

Software

Computer applications are necessary to communicate between a multi touch display and a computer.

These applications can be developed within several languages / programming environments.

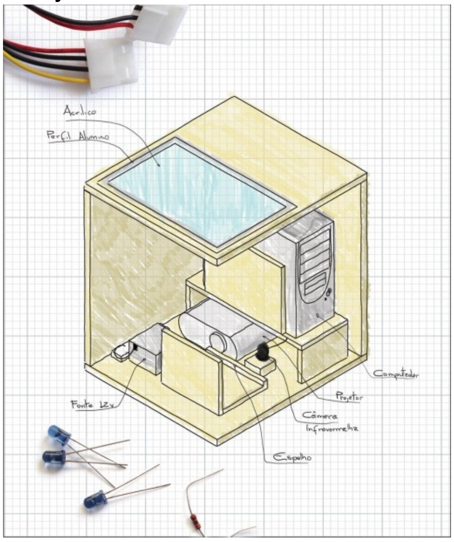
To make the multi touch table you would need the following software

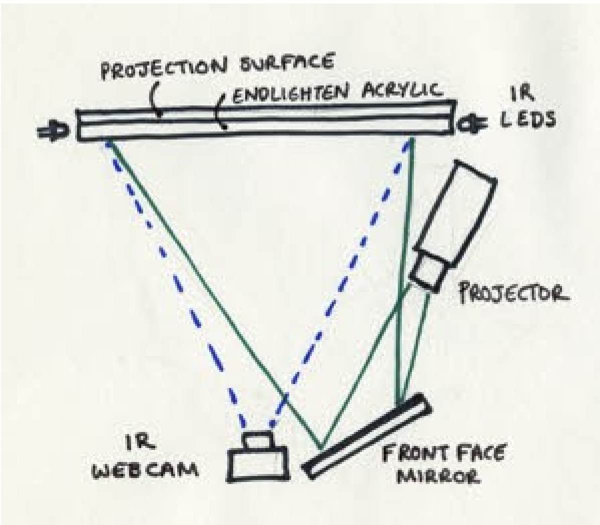
1. Microsoft Windows 7 (preferably professional or higher versions)
2. Driver for the camera (usually integrated in the software)
3. Multitouch Vista (http://multitouchvista.codeplex.com)
4. Quicktime Player (http://www.apple.com/quicktime/download/)
5. Windows SDK with .Netframework 3.5 (http://www.microsoft.com/download/en/details.aspx?id=8279)
6. CCV 1.4 (http://nuicode.com/projects/ccv/files)
7. Microsoft Visual Studio 2008

Hardware Setup

Making the Table

Construct an engineering drawing of a table deciding the location of each element in it. Also decide the angle of inclinations for mirrors cams etc beforehand. Try to make the mirror and the projection angle adjustable





Construct the table according to the specified dimensions and angles and test it by keeping your equipments in place. Make sure that in your design the table does not wobble much and touch surface is at sufficient height

Modifying the camera

Open the camera to remove the infrared filter over it. Replace it by a piece of darkened photographic film. This film works as a filter that blocks all the visible light and only allows the visible infrared to pass through it.

The photographic image seen should look gray and white when seen through software that reads camera. You'd see that every object gets illuminated and the picture is very clearly visible but that's because infrared from sun falls on every object on which visible light falls. So be sure that the filter is working.

The Infrared Plane

Set up the Lasers at four corners of the table. Add the 89^{o} line generators to them and test if the blob of hand is detected by the webcam on touching the surface.

The Software Part

For this we advise you to run the installation of all the software in "run as administrator" mode. Install Windows SDK and Quick time player on the computer. You should have visual C++ redistributable 2005 installed on the PC. Extract the zip files of CCV 1.4 and Multitouch Vista. In the folder in which u extracted the multi touch vista zip file, you will find the folder called driver. Install the driver depending on which system you are using by clicking on the install driver.cmd. Once the driver is installed, go to device manager and check if u have a device called Universal software HID Device under the Human Interface Devices option. Disable and re enable that device. Open CCV and configure it using the various functions. Save the config.xml file and launch tbeta to see the new settings. After CCV has been configured, go to the folder of multitouch vista. First run multitouch.service.console.exe. Then microsoft.multitouch.configuration.WPF. Select the TUIO tab and click the arrow button. Now open multitouch.driver.console.exe

After this your multitouch computer is ready for use. For preinstalled games and apps download Microsoft touch pack from the Microsoft's download centre and enjoy your first multitouch table.

Problems Faced	**The Problem**	**The Solution**
CCV 1.3	We had initially started with CCV 1.3; however, there was a problem in this software, with communicating with the TUIO port.	Finally we had to upgrade to CCV 1.4, however we tried changing the port number in the file config.xml in the CCV folder. We also tried changing the ip from localhost to the network ip of the computer and then ping it using command prompt. However we received no response, and the problem with CCV 1.3 was left unsolved.
Selection of the Filter	Initially we had chosen a X Ray	We replaced it with a

	film as an infra red filter for the camera, however it didnot filter our IR selectively and blocked both visible light as well as IR equally.	photographic film
Running of CCV	CCV didnot run, it just opened a command prompt and did nothing else	We installed Quickplayer from Apple's site. Run the program under the admin mode
Installation of multi touch driver	On clicking driver install.cmd a brief command window opened and closed showing the error devcon failed	Right click devcon.exe, go to properties and check the run as admin option under the compatibility tab.
Intensity of laser too less when connected from usb	We were powering lasers from usb, and the intensity of reflected light that was received by the camera was too less	The matter is unresolved, however we made an experimental arrangement with a slit in front of a series of IR leds, it had limited success and needed further development

Future Prospect

1. Bluetooth sharing

Any device with Bluetooth could be used to share pictures and multimedia files directly with the table in a very convenient manner. A device which is already paired with the Table's computer will automatically connect with the table with placing it on the table, and all the relevant multimedia files will be displayed in proximity of the device. Files could be shared by throwing them either from the device's circle (established where the device has been kept on the Table) to the Table or vice-versa.

The true identity of the device and correlation with its position on the table is established from data from the TUIO input from the webcam, (as the object will also be reflecting infrared) and by estimating the distance of the device from the table by using the signal strength between the device and the table as measuring criteria. Accuracy can be improved using more than one Bluetooth stations to estimate distance from different locations on the table.

<u>Requirements</u>

This part of project requires in-depth knowledge of Bluetooth networking, Visual Studio, and other Programming language.

2. Smart Card Reader

The Table can be made capable of reading smart cards either containing optical appendages (IR reflectors) or magnetic appendages (like the credit card)

Special cameras and magnetic instruments come which can identify these cards by visually analysing them. Such cards can be used in malls for the purpose of quick and effective payment. A changing room of the future where people test the clothes they want to buy on their avatars and they pay their payments by just placing their smart cards on the table.

3. Super Table

CCV can be modified to take input from multiple webcams to increase the size of the table. If this is done, a table as big as a conferencing Table can be converted to a touch panel by mere usage of large LCD panels or projectors with super large throw ratio. The server could be modified to share all the details of the conference meeting, completely eliminating the use of papers. Also each part of the server will serve to an individual person as his independent space for storing his notes, files etc. (this idea can also be implemented using multiple projectors and computers with one server, interacting as many touch tables connected to each other)