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NON PHYSICAL TOUCH DETECTION USING INFRARED LASER

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Abstract: Recently significant improvements have been made in field of touch sensing technology. Physical touch detection has evolved and a number of such technologies exist today.

However non-physical touch detection is still popular in those applications which may demand such an attribute. This paper explains functional aspect of such a technology. The use of infrared laser light, infrared photo detector along with necessary hardware has been demonstrated.

Keywords: Infrared laser, Multi touch detection and Non-physical touch detection.

1. Introduction

Physical touch detection is commonly used in those applications where physical stimuli could be detected. A touch sensitive grid may be layered on the top an electronic display. Such a detection system can have many disadvantages. A typical touchscreen cannot be used to detect large areas and is usually integrated with display underneath.

These touch screens need massive computing power and the problem of ghost touches can be observed if integrated poorly with software. In touch detection of large area it is better to use a non-physical touch detector (NPTD).Such a device would consume less power and is quite accurate on this scale. NPTD is a cheaper way of detecting touches on a large area. It can also be improved by implementing gesture recognition algorithms.

NPTD can be integrated with an image projector and computer. NPTD array can be placed on projection screen on which the projector can project images. Here NPTD is used as an input device which will sense touches. A two dimensional array of touch detectors is placed along the projection screen. An array of NPTD consists of infrared lasers lined on two sides and other two opposite sides consist of photo detectors.

2. Proposed Hardware for NPTD

A) Infrared Laser

Infrared light is a form of invisible electromagnetic radiation with longer wavelengths than visible light. IR is usually divided into three spectral regions namely near, mid and far. [1]

Spectral Region	Wavelength in(micron)
Near IR	0.7 - 5
Mid IR	5 - 40
Far IR	40 - 350

Typically 700nm to 1050nm range is selected for this application. Lasers emitting within this range can be used. Typically IR range is selected to obviate visibility in this region.

However this range is not "Eye Safe" and may harm eyes if exposed for long periods at high intensity. Hence an array of low power lasers is chosen.IR lasers are placed on inner linings of a two dimensional frame. Highly coherent and unidirectional beam is necessary for this application. Such an array can be placed in a metal cast rectangular frame for improved directionality.

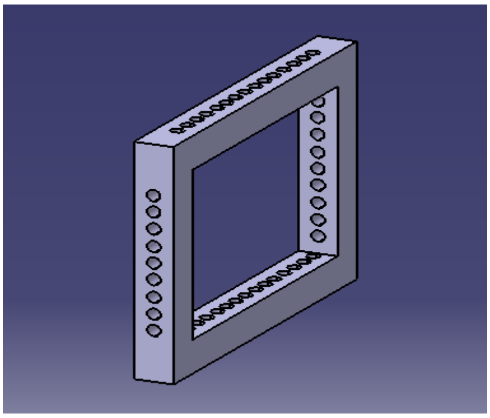


Fig. Rectangular cast with holes on each side for inserting IR lasers and photodiodes.

B) Photo Detector

Since an IR laser has been used it is necessary to use a photodiode which can detect light in this range.

A photodiode is selected considering its spectral sensitivity range and half angle. A typical IR photodiode is capable of detecting light within range of 700nm to 1050nm is selected. Half angle should be minimum to avoid interference of external IR emission.

A Half angle of about 10-20 degrees would be ideal for such application. However effective half angle can be reduced by adding extra travel in front of sensitive area.

C) X-Y Plane Mapping

Mapping of x-y plane is shown in following diagram. The number of detectors on x axis are **n** and that on y axis are **m**.

A typical **m*n** matrix implementation is represented where **m** may or may not be equal to **n.**

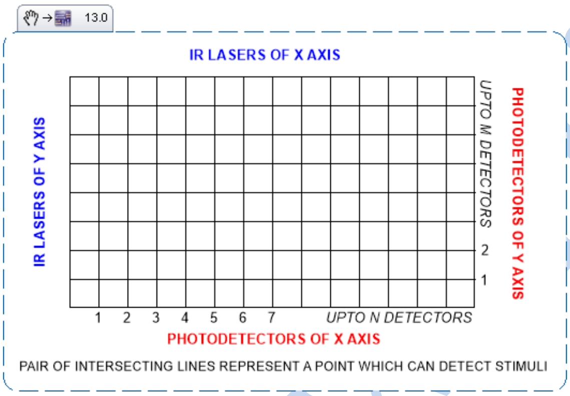


Fig. An array of photo detectors with IR lasers on ***x*** and ***y*** axis

Photo detectors on x axis are named as ***x1, x2, x3 …xn*** and those on y axis are named as ***y1, y2, y3…ym.***

Hence every point on the 2D plane has unique location ***(xn, ym)***.

D) Hardware Operation

Detection of stimuli on 2D plane will trigger reduction in IR light intensity. The stimuli will block the path of IR light at such a point namely ***(xn, ym).*** This causes an increase in resistance offered by photo detectors. Since amount of IR light intensity is inversely proportional to resistance offered by photo detector.

A hardware based electronic system is designed to detect this change. From the statistical data it is concluded that photo detector has high resistance at less intensity of IR light. Moreover possibility of spurious IR emissions directly incident on photo detector is minimal.

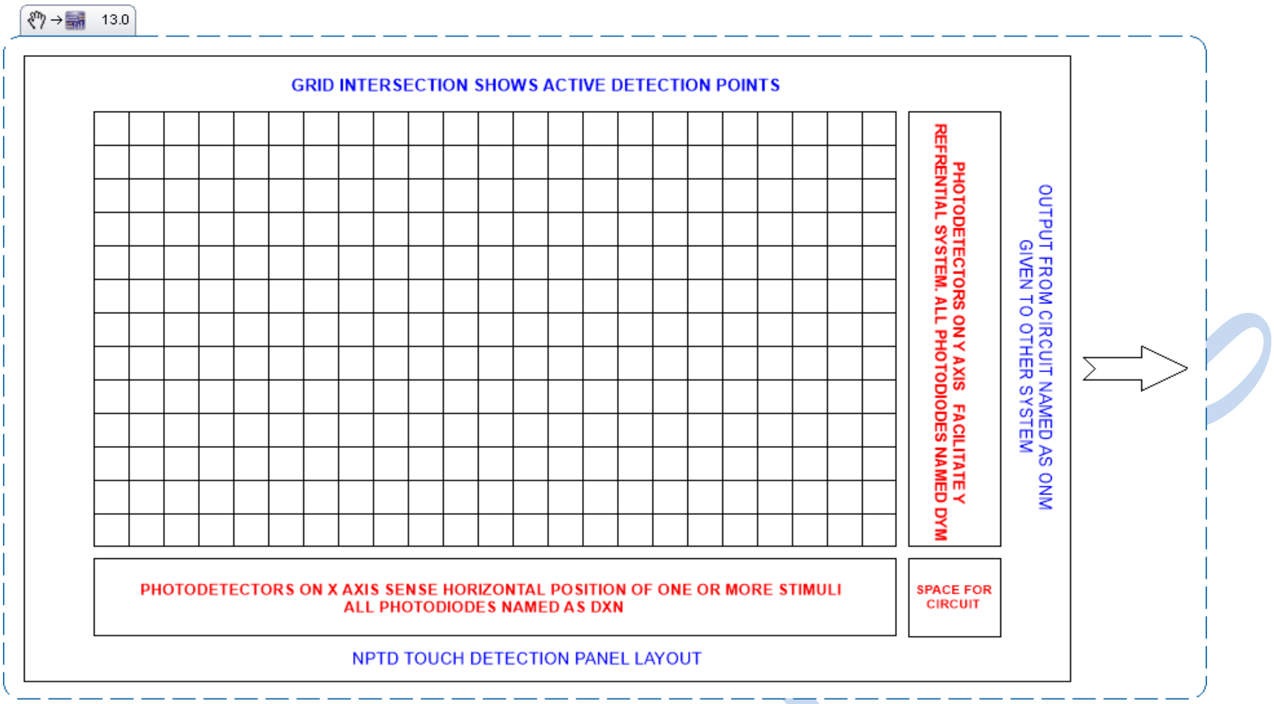
When a stimuli blocks path of light IR emission intensity will reduce significantly. Photo detector offers very high resistance to current flow acting as open switch. A typical point stimuli on 2D will trigger two photo detectors, one on each axis.

When no stimuli interferes, the intensity of IR emission will be maximum. Hence photo detector offers low resistance to current flow and acts as closed switch. However forward voltage drop indicates that forward resistance is not negligible.

A Y axis referential system is used in designed hardware. However an X axis reference system is possible to design as well. An axis referential design system is followed for simplification of hardware and to bring uniformity in design. This design shows a circuit model which consists of ***m*** detectors on Y axis and ***n*** detectors on X axis.

The IR lasers are not involved in any other sensing or switching functionality. Their requirement is only limited to continuous emission of highly directional IR rays on photo detectors.

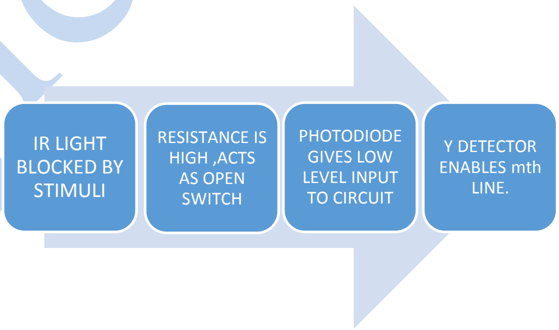
E) Block Diagram

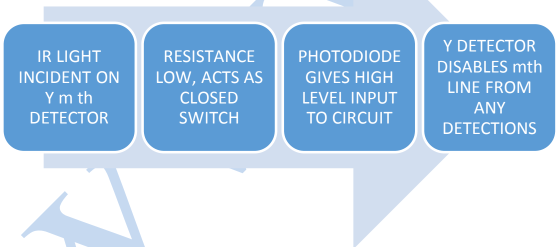


The working of circuit is based upon inputs received from photo detector in reversed bias configuration.

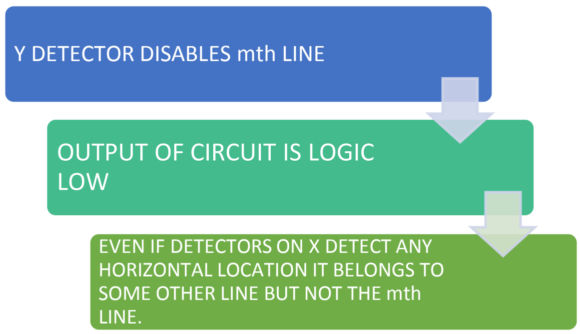
1) Activation

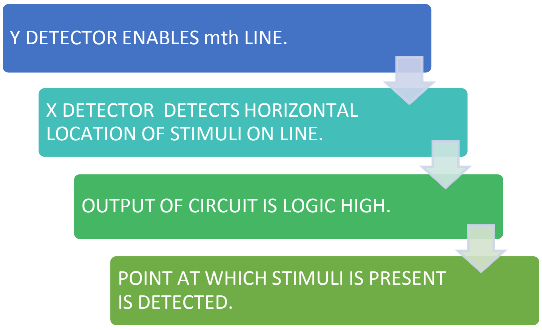
A circuit is only activated with reference to detector on Y axis and hence called as Y referential system.





Hence circuit in horizontal line is activated first by Y detector. Then detection control is given to detectors on X axis which detect position of stimuli on horizontal line.





2) Circuit Input/Outputs

The inputs are given by **DXN** and **DYM** format where:-

1) DXn

DX: Diode on x axis

n: Location on x axis

2) DYm

DY: Diode on y axis

m: Location on y axis

The output of a point is given by AND gate corresponding to it. The naming of outputs is done as where:-

1) Onm

O: Represents output

n: Location on x axis

m: Location on y axis

Onm=LOGIC HIGH	STIMULI PRESENT AT POINT (n, m)
Onm=LOGIC LOW	NO STIMULI DETECTION AT (n, m)

3) Use of Output from AND gates

The outputs from the circuit can be given on an ***m*n*** LED array. The corresponding location detection will be shown on the 2D array. However this won't have any practical application. Hence the outputs of NPTD must be given as inputs to other system. Here NPTD will act as pointing or gesture sensing device similar to any other touch panel.

It will be able to detect **multi touch** as well. Since every point can be individually detected. Simple finger touches can be easily detected. Even **magnetic** and 2D objects which have symmetry on both the axis are detected. However **intricate** and **transparent** objects cannot be detected. NPTD is basically designed to detect point stimuli and gestures. It is not designed to detect large non symmetrical parts. For such applications a different provision is discussed later in this paper.

4) Integration of NPTD with External Systems

Integration with Computer and Projector

The integration of NPTD with computing system and a projector will bring actual functionality to it. Hence NPTD can be used as an input device to system. A projector is used to display on a screen. The sides of screen are surrounded by the NPTD frame. A gesture recognition software needs to be developed to go with it.

Outcome would be a big screen which is sensitive to touch and gestures. Hence need for reaching out for mouse or keyboard is eliminated.

An on screen keyboard, calculator etc. could be used to edit text or solve problems. Artists could draw freehand drawings on big canvas. Even complex designing can be done by many people simultaneously.

3) Conclusions

The resulting technology could be used in schools, corporate boardrooms, whiteboards, training and conference rooms. Power consumption would be minimal as only 6V power supply is needed for detectors to function. IR lasers of less power could be used if they are directional.

The actual production cost will be lesser as it uses cheap components like basic logic gates. A microcontroller could be used to make design simplistic.

System could be used either vertically or horizontally on a flat surface. Back projecting system could be used to eliminate shadows while interacting with the screen. Presentations and seminars could be given easily without interruptions for handling mouse or keyboard.

NPTD is lightweight, durable and can be shifted anywhere easily. Ability to detect variety of materials like hands, magnetic, non-magnetic and metallic pointers too. Sensitivity and accuracy can be increased by adding more pairs of sensors on both sides.

4) Future Work

NPTD panel can be optimized for many other applications like dimension measurement and shape detection. This would require custom made software algorithms to go with it. Even a change in hardware and circuit would be necessary for this application.

With such a device it is possible to detect dimensional inaccuracies and potential flaws in objects. The process of quality control can become faster and more accurate. This solution will prevent human interference and will facilitate automation in industries.

5) References

1) IR Near, Mid and Far spectral range. www.ipac.caltech.edu/outreach/Edu/Regions/irregions.html

2) IR information taken from

www.missionscience.nasa.gov/ems/07_infraredwaves.html

3) Photodiode operation taken from

www.azooptics.com/Article.aspx?ArticleID=809

4) Photodiode theory and types taken from

www.radioelectronics.com/info/data/semiconductor/photo_diode/operation-theory.php

www.globalspec.com/reference/typesofphotodiodes

5) IR Laser information taken from

www.optotronics.com/ir-lasers.php