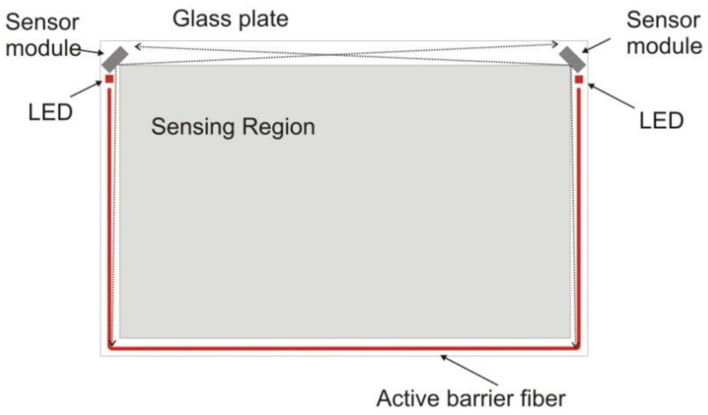
Crystal-Touch® Optical Touch Screen Technology Overview

GPEG GmbH
Muenchener Str. 17
D-85646 Neufarn
Tel: +49 (0) 89 90 89 95 20
Fax: +49 (0) 89 90 89 95 21
info@touchtop.de

Introduction

Lumio has developed a unique edge emitting plastic optical fiber element that efficiently generates thin, planar light fields adjacent to a touch surface. This fiber element; the Active-Barrier®, is placed at the edge of the touch surface along three sides, illuminating a thin layer just above the surface. High speed, high resolution linear optical sensors are placed along the fourth side of the touch surface to sense interactions with the light field. Both the illumination fibers and the sensors are embedded in a thin frame, 4 millimeters high, which can be bonded directly to a display glass or surface. The optical efficiency of the Active-Barrier® fiber enables the sensing frame to be scaled up to cover very large interaction regions. Multi-touch operation is also supported by incorporating additional sensors and/or detection zone separation.

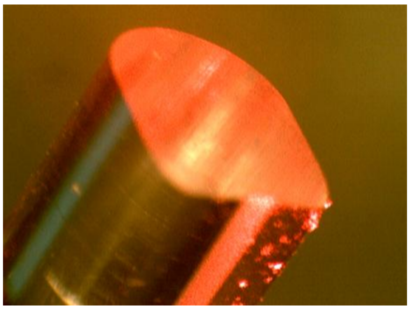
Triangulation based optical sensing

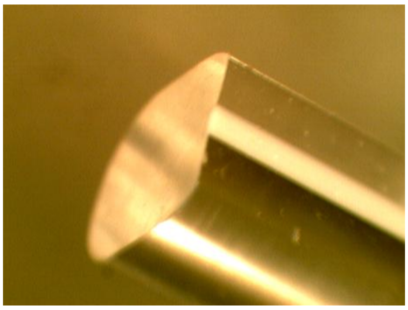


Schematic illustration of the optical touch screen plate showing the location of the sensor modules, active-barrier® fiber and infra-red illumination light emitting diodes.

The basic construction of Lumio's sensing frame comprises two high resolution linear optical imaging modules located along one edge of the sensing region and an optically emitting active barrier located around the other edges as shown in the accompanying figure. All of the components can be mounted either on a self contained frame that surrounds the sensing region or directly onto the glass plate that defines the front surface of a display, providing high resolution optical sensing with no wear and no degradation of display quality. The barrier floods the region in front of the interaction surface with a thin layer of light that is directed towards the sensors from all directions providing a uniform reference signal. When an object is inserted into this plane the imaging sensors will record a decrease in the light from a particular direction and the location of the object is determined by a triangulation technique. Sophisticated and proprietary algorithms are used to enhance the resolution near the sensor baseline. Since the sensing relies on blocking of the reference light emitted by the barrier it will respond to any object under just about any conceivable illumination, including sunlight exposure.

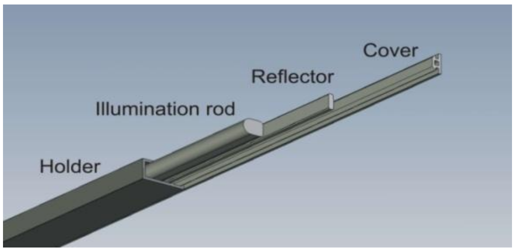
The Active-Barrier® illumination





The active barrier is comprised of a customized edge-emitting fiber-like plastic rod that provides uniform illumination along the perimeter of the touch screen. The patented rod structure is designed with an internal scattering component and a non-circular cross section that is optimized to extract light along the length of the fiber from one edge only and focus it into a parallel beam. Invisible, infra-red light from LEDs is coupled into the rod from either end to illuminate the entire length which then emits a uniform, thin planar beam of light that completely fills the sensing region. The optical efficiency of the active barrier technique, in which the LED emission is almost entirely re-directed into the sensing plane, enables the frames to be scaled up to very large dimensions without requiring multiple discrete illuminators placed around the edge.

The rod is inserted into a plastic holder that can be bonded directly to the glass substrate. An exploded view of this assembly is shown in the accompanying figure. A reflecting element is inserted behind the rod to increase the optical efficiency of the illumination and the electrical wiring is also run inside the holder. Finally, a plastic cover is then attached at the back to seal the structure. The entire assembly can be sealed to IP65 specifications if desired.



Highly sensitive touch response

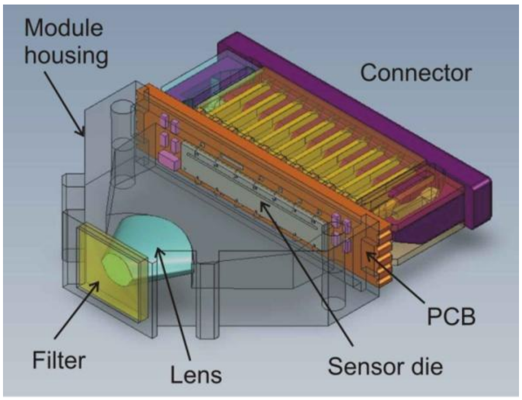
It is the position of this illumination along with the sensing modules with respect to the screen that determines the actual location of the sensing plane. For small sensing regions fibers as thin as 1mm may be used. For large screens, white board and tabletop applications fibers with 3 mm diameters are typically used. In either case a finger must be brought essentially into contact with the screen in order to activate the touch sensor just as with ordinary touch screen technologies

Better performance than retro-reflective optical technology

The active barrier has an additional advantage over more conventional retro-reflective based optical sensing techniques since the distribution of light around the edge avoids the hot spots that occur near the LED illuminators. Since the light source must be placed very close to the sensors in a retro-reflective type touch panel the sensors are typically offset from the active area by tens of millimeters in order to avoid saturation of the sensors. The Active-Barrier® illumination on the other hand allows the sensors to be brought much closer to the active area minimizing the touch panel footprint.

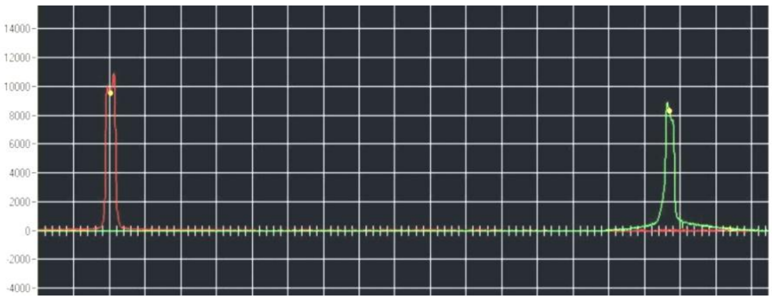
The optical sensing module

The optical sensing modules are based on high resolution linear CMOS images sensors. The sensor die contains 2048 pixel. The modules are designed to be placed at the corners of the screen, with a 90 degree field of view such that two modules placed at adjacent corners provide over 4 million discrete sensing points across the screen. Sub-pixel interpolation is then used to increase the actual resolution to over 12 million points. While the actual resolution will vary over the sensing field this is sufficient to provide sub millimeter resolution over the largest display systems. A typical sensing module consists of a linear sensor die, focusing lens, IR filter and aperture stop packaged into a 4mm high package as shown in the accompanying figure.



Touch screen operation

When a finger or other object touches the glass surface it blocks the light from the barrier that would otherwise reach the sensor from that direction. This results in a change in the signal on the CMOS sensor at a particular location. A sophisticated algorithm is employed to process the data, filter the signal and subtract background interference. This processing enables robust operation under any ambient illumination, including sunlight. A representative image of the sensor signal from two sensor modules is shown superimposed in the figure below. The location of each peak along the linear sensor corresponds to the direction of the object and the absolute location of the object is then triangulated by the control board and output with standard touch screen protocols.



Output of the left sensor module (red) and right sensor module (green) for an object activating the touch screen.

Intellectual property

Lumio's Crystal-Touch® optical technology is covered by 5 issued US patents along with parallel international filings under the Patent Cooperation Treaty (PCT). These patents cover various aspects of the Active-Barrier® illumination assembly, general optical touch screen structure and advanced detection algorithms giving Lumio a very strong patent position in the field of optical touch.

Conclusion

Optical imaging is the method of choice for touch activating medium and large scale surfaces. This is primarily a result of the scalability of optical techniques when compared to physical overlays whose cost grows exponentially as the size of the interaction area increases as a consequence of, among other things, yield issues. Additional benefits include the fact that as a completely digital solution optical imaging is free from the drift and aging that plague resistive and capacitive technologies so systems never needs to be recalibrated. A fast sensor response time minimizes latency and a high frame rate coupled with high optical resolution provides the performance required for high end sensing applications such as graphic stylus input and jitter free cursor control.

TOUCHTOP.de

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