Fault Tolerance in Touchscreens

Touch screens are becoming prevalent in a wide range of industries such as retail, digital signage, business and collaboration spaces, and healthcare. With the use of interactive displays becoming more popular there is now a need more than ever for a well performing and reliable touch technology. Many operations cannot afford to have their touch screen become sluggish or unresponsive so it is very important that when choosing a technology to adopt that any potential pitfalls are carefully considered.

In most traditional touch technologies such as IR beam break, optical camera, or projective capacitive, a loss of one or more key components can result in a significant decrease in performance or total failure of the system. Let's examine the weaknesses of these technologies.

IR beam break touch technology relies on sensors and emitters creating a grid pattern across the touch area to recognize and compute touch events, as illustrated in *Figure 1*. When a touch object enters the touch area it blocks a beam of light being emitted resulting in no light being cast into the corresponding sensor. When this happens the touch screen recognizes a touch event has occurred and relays this information to the host computer. One of the biggest flaws with this design is any sensor or emitter failure results in a dead band or zone on the screen where touch events can no longer be recognized. A single sensor or emitter failure results in an entire row or column of the touch screen to be broken with no opportunity of recovery.

With camera based optical systems the cameras are usually positioned in the corners of the screen, as shown in *Figure 2*, in order to capture images of the entire touch area. The images captured of the touch area are then used to compute the position of the touch point. Any failure of one or more of the cameras results in

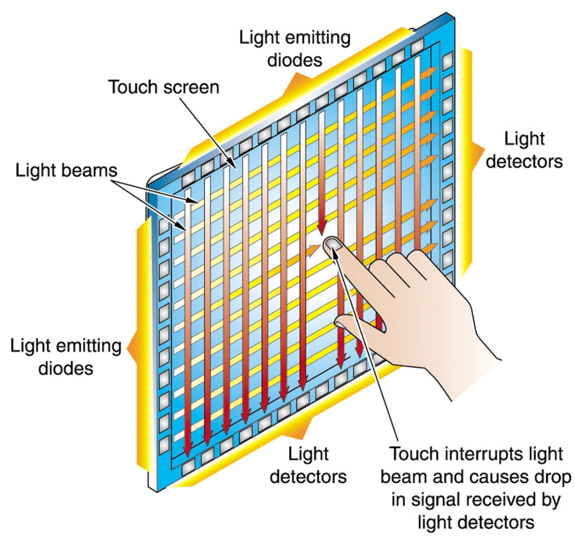

Figure 1: IR Beam Break Touch Technology

the touch screen no longer being able to function properly. The image used to compute the touch position will either be distorted or missing altogether. This typically results in missing or ghost touches.

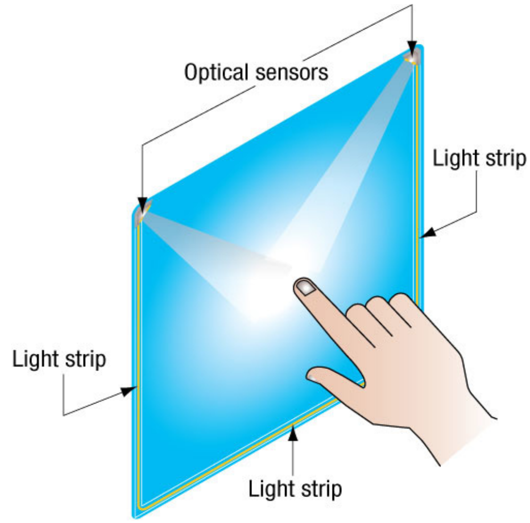

Figure 2: Optical Touch Technology

Projected capacitive (PCAP) touch technology utilizes a matrix of conductive material which is usually layered onto polyethylene terephthalate or Indium Tin Oxide, shown in *Figure 3*. This layer is then sandwiched between the display and a protective piece of glass. A voltage is then applied to the matrix which creates an electrostatic field. A touch event is detected when a finger or conductive stylus enters the field and causes a distortion. The distortion is measured which allows for the touch position to be computed. If the matrix of conductive material is damaged in any way the screen will no longer operate appropriately because the electrostatic field that is required to determine touch points will no longer be present.

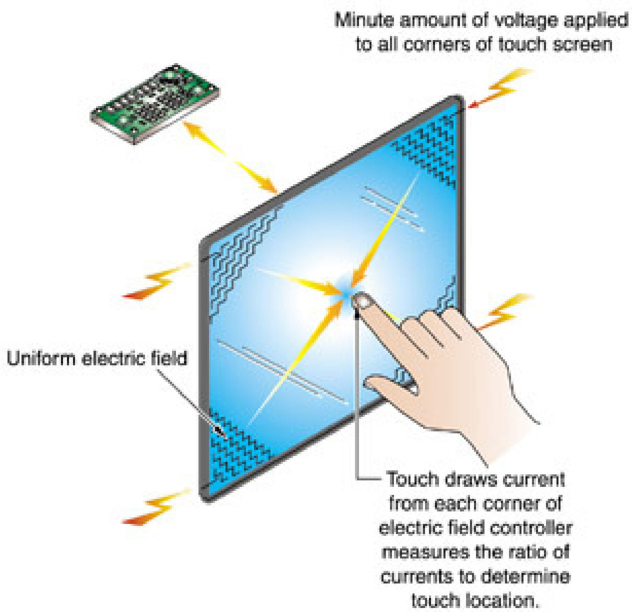

Figure 3: Projected Capacitive Touch Technology

Baanto ShadowSense touch technology is an innovative and patented optical position sensing technology. Unlike other optical technologies that utilize cameras or imaging arrays, ShadowSense designs use high performance sensors operating in the analog domain to provide unprecedented performance, stability, and accuracy. Featuring an efficient sensor architecture coupled with elegant position detection algorithms, ShadowSense designs overcome many of the challenges faced by traditional touch technologies.

ShadowSense touch technology has a very robust architecture allowing for elegant failure. This means damage to the glass or failure of a few sensors and IR LEDs does not result in significant degradation of performance or accuracy. ShadowSense touch is a bezel based technology which decouples the touch detection from the protective glass used to cover the TFT surface. This approach eliminates the coatings, films, and glass dependencies characteristic of the conventional overlay technologies such as resistive, surface acoustic wave (SAW), surface capacitive, and projected capacitive. The result is improved optical performance, durability, reliability, and environmental stability.

A typical configuration of a ShadowSense touchscreen utilizes six (6) sensors on the top bar; one in each corner and four mid-span. For illumination, 940 nm IR LEDs are deployed on both sides and the bottom of frame. This is shown in *Figure 4*. Each sensor can detect all of the IR LEDs in the frame which allows the ShadowSense touch frame to have the ability to continue performing even with the failure of multiple IR LEDs. Due to the redundant design, when there are failures present in the system there is still enough data obtained to calculate the position of the touch object.

ShadowSense touch is based upon the precise and accurate detection of an object's shadow as it enters, hovers within, or transitions out of a sensor's field of view. The object's position in the touch plane is then calculated based upon the ratio of a fully illuminated condition to the shadowed state for multiple light sources and multiple sensors. A touch point can be calculated as the intersection of all the shadows being cast into the sensors. With the robust architecture of the ShadowSense frame, if LEDs begin to fail the sensors can obtain the necessary shadow data from an adjacent LED and continue to track the touch position extremely accurately.

An automated robotic system was utilized to perform a series of rigorous tests on the ShadowSense touch frame to measure the performance and accuracy degradation as LEDs were both de-rated and removed throughout the frame.

The first series of tests that were performed analyzed the limitations of non-consecutive de-rated LEDs. During the testing, multiple LEDs were de-rated with very minute variance in accuracy of the touch points. The limit of de-rated non-consecutive LEDs was approximately 26% before areas of the screen could no longer recognize touch events. The same series of tests were performed a second time but instead of de-rating the LEDs they were completely removed resulting in no light being emitted compared to the significantly decreased brightness in the de-rated LED testing. The limit for dead or removed LEDs in the ShadowSense touch frame was approximately 18%.

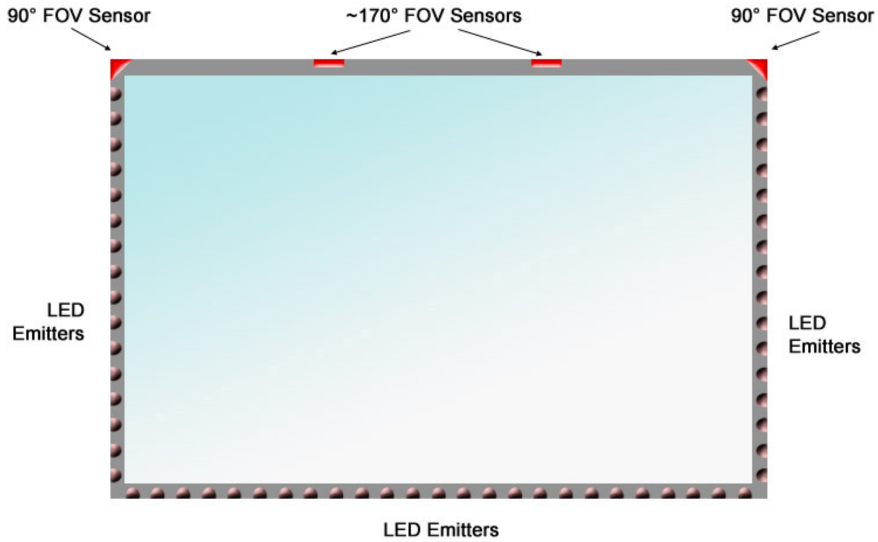

Figure 4: ShadowSense Touch Technology

The second part of the testing investigated the limitation of consecutive de-rated LEDs. When a few consecutive LEDs were de-rated there was little to no evidence of any change in performance or accuracy of the touch event. As more consecutive LEDs were de-rated the accuracy of the touch position decreased slightly in the area where the LEDs were being de-rated only. Up to 27 consecutive LEDs were de-rated without a single touch point being missed. The same tests were executed a second time but consecutive LEDs were removed (dead) instead of being de-rated. With the consecutive dead LEDs there were some performance issues that arose as compared to the de-rated testing. Test points were missed when 3 consecutive LEDs were removed. The difference between the failure of the consecutive and non-consecutive test unit was that with the consecutive tests there was only localized failure, meaning the rest of the touch area maintained great performance while only the small area close to the dead LEDs suffered. For more detail regarding the testing setup and procedure see the Fault Tolerance Reports.

For more information about ShadowSense, please contact a member of our sales team at sales@baanto.com.