Touchless Gesturing Brings New Innovation to Electronic Product Designs

Multi-Axis Infrared Proximity Sensing Ushers in the Next Generation of User Interfaces

Human-machine interaction has evolved significantly over the past decade through enhancements in user interfaces and smart design. Many of these changes have focused around touchscreen interfaces with high-precision, low-power capacitive touchscreens at the forefront particularly in the handset market. Now, through advancements in human interface (HI) technology and design, infrared proximity sensors are poised to usher in the next user interface innovations centered on touchless gesturing.

Traditionally infrared proximity sensing systems have incorporated legacy photo-detectors and photo-interrupters, which trigger based on motion or interruption respectively. These proximity sensing solutions are used extensively in automatic doors and lavatory dispensing systems, but the applications have been limited due to the sensor size, power and configurability. More advanced active proximity sensors offer exciting features and promise enhancements to consumer electronics and industrial products. Next-generation infrared sensor offerings, such as Silicon Labs Si114x touchless sensor IC family, are not only smaller and lower power than previous offerings, but also have the ability to drive multiple infrared light emitting diodes (LEDs), thereby enabling advanced gesture inputs in multiple dimensions.

Evolution from Single- to Multi-LED Systems

Single-LED driver proximity sensors have been used in touchscreen handsets for many years and represent the highest-volume proximity sensor market, but their use has not been without issues. For example, although proximity sensors are used to deactivate handset touchscreens during calls to eliminate errant touches by the cheek, a quick web search reveals that many end users are unhappy with proximity sensor performance in their handsets. Accidentally muting calls, initiating conference calls and hanging up on callers are frequent mishaps caused by erroneous proximity sensor operation.

Why does a seemingly simple proximity sensing system malfunction so frequently? The answer lies in the sensor design and configurability as well as the mechanical guidelines that accompany them. Many infrared proximity sensors are just that: dumb sensors that output raw data based on the signals received. The sensors do not have any onboard smarts to aid in distinguishing system noise from an actual signal, and they have trouble operating in environments with high ambient infrared content such as full sunlight or rooms lit by incandescent light bulbs for example. Furthermore, with industrial design taking an increasingly important role in the appeal of modern electronic systems, these proximity sensors are ill-suited to operate behind very dark overlays that limit the amount of visible and infrared light reaching the sensor.

The latest generation of proximity sensors, such as Silicon Labs' Si114x family, addresses the shortcomings associated with poor proximity sensor operation. The advanced architecture of the Si114x sensors as shown in Figure 1, for example, features multiple high sensitivity photodiodes coupled with a high-precision analog-to-digital converter (ADC) to enable measurements with the infrared LED on for a fraction of the time (25.6 microseconds) of other less advanced sensor offerings. This short LED on-time enables the sensor to determine and compensate for ambient infrared levels in the environment and to better distinguish them from the actual proximity measurement.

Faster measurements also have the benefit of reducing overall system power. The infrared LED is the biggest contributor to a proximity system's power budget. Minimizing the time that the LED needs to remain reduces the overall system power consumption. With 15 dynamically adjustable LED drive settings, the LED drive strength can be adjusted based on the ambient infrared conditions, thereby saving power and leading to a more energy-efficient design. The LED no longer must be set at a power-hungry maximum setting. Highly sensitive photodiodes also enable the sensor to operate behind very dark glass so that the electronics can remain hidden to the human eye, resulting in cleaner, sleeker industrial designs.

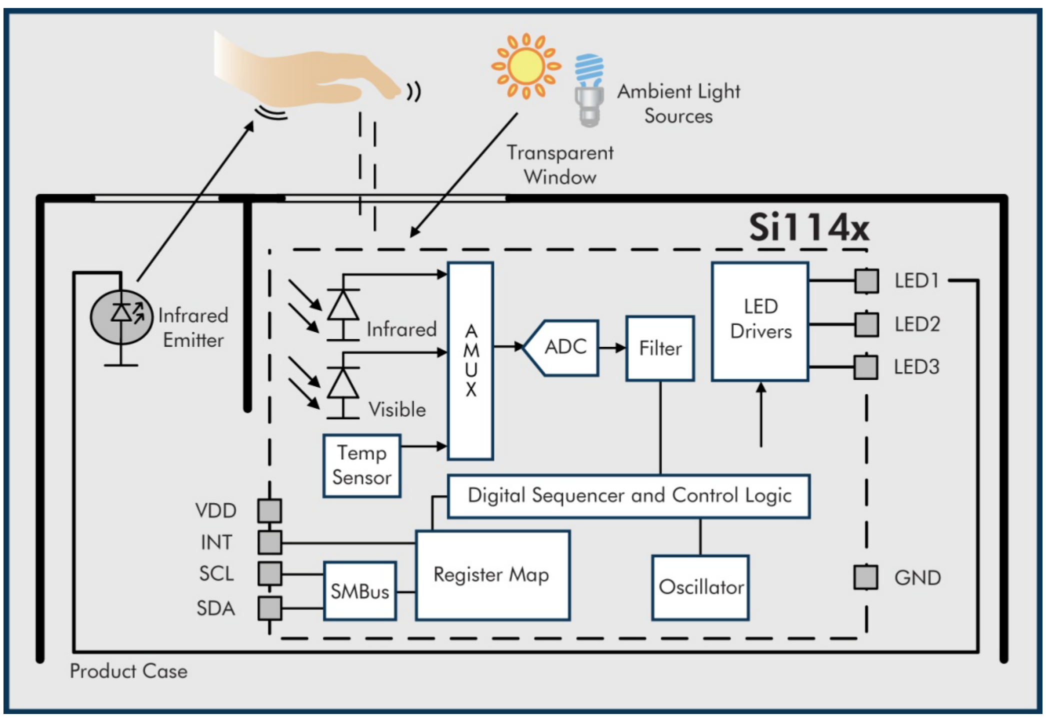

Figure 1. Si114x Proximity Sensor Enables Multi-Dimensional Touchless Gesture Interfaces

Triple the LEDs, Triple the Innovation

While single-LED proximity systems are driving today's market, the future is geared toward multi-LED proximity sensor systems enabling unique innovations in user interfaces. Two-LED infrared systems enable slide and select gestures for use in applications such as page turning in e-books, volume selection in home audio equipment, or scrolling in tablet PCs. Three-LED proximity systems can be used for 3D positional calculation and multi-axis gesturing. These three-LED systems can be used for touchless UI navigation such as icon or photo selection, zooming-in and out in mapping applications, or even game controls. Other, more exciting applications for two- and three-LED proximity systems are limited only by the designer's imagination. Just as capacitive touchscreens ushered in a new era of user interfaces, touchless gesturing technology will similarly change how end users interact with electronics products. Two- and three-LED infrared proximity sensor solutions are ideally suited as touchless gesturing solutions in these systems.

Touchless Benefits include Health, Safety and Convenience

A valid challenge to touchless interfaces is why they should be implemented at all. Why do away with tactile buttons and touchscreens if they work? Infrared systems are not going to replace existing systems, but instead they are going to augment the user experience. Increased integration and miniaturization are changing the way customers use electronics products. No longer are "computers" relegated to use in the home study or on an office desk. These days people travel everywhere with their smart handsets, personal media players, e-books and tablet PCs.

Coffee shops, restaurants, gyms, bus stops, plane terminals and even lavatories are fair usage environments for this new generation of embedded electronics. In such diverse operating environments, users' hands are sometimes occupied, dirty, sweaty or covered in food -- all conditions not conducive to touchscreen operation. If a customer is reading an e-book at the gym while on a treadmill and wants to turn a page, it would be a much easier to swipe across the device with a touchless gesture to turn the page rather than physically contacting a touchscreen or hunting down a small button.

Being able to control a device without having to look at it has additional benefits. For example, a touchless interface can allow an automobile driver to safely start/end a call or adjust volume with the touchless swipe of a hand without having to navigate through a complicated instrument cluster to find control buttons. Not all devices have or need complex graphical displays with touchscreens either, and for such devices a touchless interface can provide an innovative and differentiated approach for operation.

Multi-LED proximity systems can be used to change the operation of a system based on a user's proximity to the system. A display for a set-top box or HVAC control panel, for example, can remain dark until the system detects a user within a certain distance, thereby saving power. A TV also can be turned on or off with a gesture-based input. Small-scale video advertising billboards within public spaces can change the context of their messages based on whether someone is near or far away and then use touchless gesture inputs to interact with the potential customer; this is a far more sanitary method display an advertisement publically than using a touchscreen. Such "environment aware" electronics can enable smarter end-products that are simultaneously more energy-efficient.

Combining multi-LED proximity sensors with host MCUs, such as Silicon Labs' capacitive touch-sense microcontrollers, opens the door to flexible user interfaces using both capacitive touch and infrared touchless technologies. Host touch-sense MCUs provide the computational power necessary to interpret the output of the infrared sensors and help to tune the timing and sensitivity of touchless gestures. The MCUs also can assist with run-time configuration of the sensors to optimize operation for low power consumption based on ambient light levels. See Figure 2 for an example of a touchless application incorporating a proximity sensor combined with a capacitive touch-sense MCU.

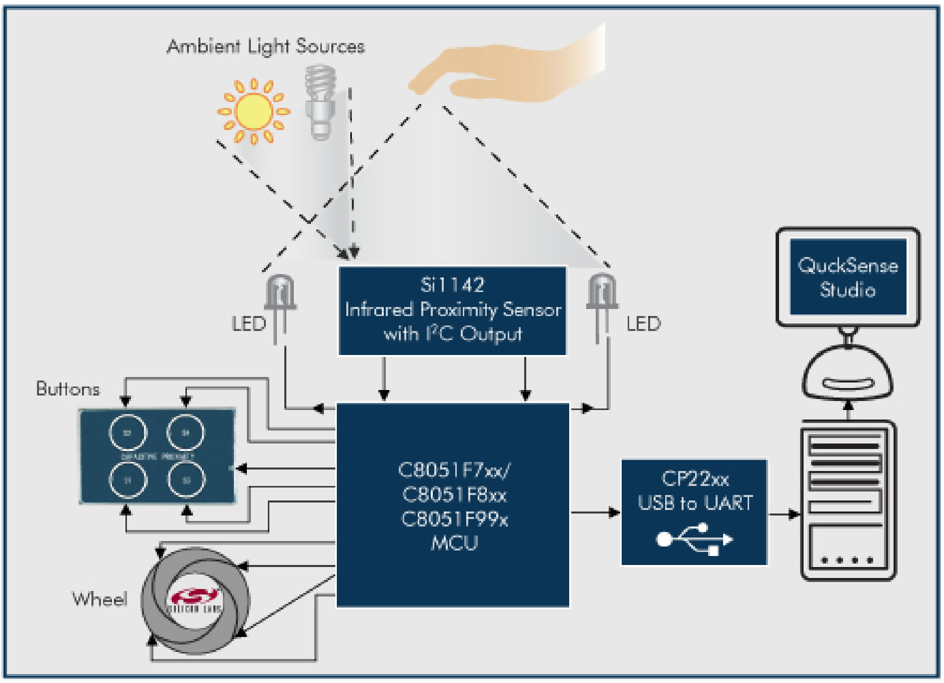

Figure 2. Touchless Interface Application Based on Proximity Sensor and Touch-Sense MCU

With the advent of more sophisticated proximity sensor ICs that support two- and three-LED implementations, embedded developers will dream up new applications for touchless gesturing interfaces that will help make electronic products easier, safer, more sanitary and more enjoyable to use. The day will soon come when even the most commonplace home appliance, handheld device, computing platform and industrial interface can be activated and controlled with the wave of a hand.