# A Better Solution for Designing Automotive Infotainment Gesture Controls

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## Abstract

Infotainment gesture control enhances driver experience and safety by helping avoid distractions caused by touchscreens and poorly located dials. Gesture recognition can complement touchscreens, voice, and knobs so that the driver can focus on the road. Time of flight (ToF) cameras, although fancy, are computationally heavy and expensive. A new, disruptive approach integrates the use of optics, sensing, and an analog front end (AFE) in a single ASIC, dramatically reducing complexity and cost, and advancing the adoption of this important technology in a wider range of automobiles.


## Introduction

Automotive infotainment gesture control, currently only available in luxury cars, increases driver safety and comfort. With gesture control, drivers do not need to risk an accident by taking their eyes off the road while operating touchscreens or dials. With gesture recognition, drivers can adjust volumes and airflow, wave away calls on connected phones, or change a music playlist with a flick of the wrist and more. Gesture control can minimize the use of touchscreens, making them less distractive, and can complement voice. For example, drivers can ask a virtual assistant to play a certain song and then, with a rotation of a hand, turn up the volume while their eyes stay on the road the entire time.

In contrast to gesture, the use of voice recognition requires an LTE connection back to a cloud processor to understand all dialects and languages, making a major database necessary. Voice recognition also does not work while windows are down, if a sunroof is open, or if music is cranked up in the car. In addition to advancing traffic safety, gesture recognition helps deaf and mute people who are unable to utilize voice recognition technologies. Touch panels are distracting, requiring drivers to memorize button locations and rely on tactile feel to navigate around the display. Finally, while touch-based commands may inevitably cause some wear on touched surfaces, gesture recognition technology does not wear down controlled devices.

Currently, only luxury or Tier 1 automobiles have adopted gesture control technologies, due to their high complexity and cost. But the benefits of this technology warrant every effort to broaden adoption across mid- and low-end automobiles. In this design solution, we discuss a typical application and introduce a new, disruptive approach that is highly integrated and cost-effective, enabling the adoption of gesture recognition by a vastly higher number of automobiles.

## Typical System

Figure 1 illustrates a typical technology that relies on a ToF camera to identify and scan a 3D scene. The ToF technique consists of sending an infrared beam to a target to be analyzed. The reflected signal is processed by an AFE and the raw data is moved along to the application processor (AP) for gesture recognition.

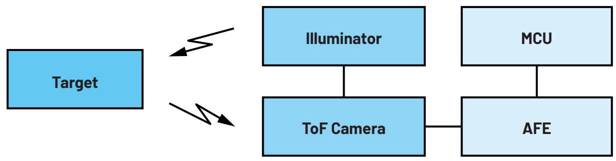


*Figure 1. Typical application using a ToF system.*

This system has a high pixel count (60,000) and can perform eye/facial, body, and finger tracking, recognize a complex gesture, and have context awareness. It produces a huge amount of data, requiring a complex microcontroller for processing. The use of a camera and a complex microcontroller makes this system versatile but expensive. ToF may offer a lot of gesture possibilities, but the complexity is too much for automotive applications, requiring customers to use a manual to program them and is not needed for everyday usage.

## A Breakthrough Technology

The benefits of infotainment gesture control warrant every effort to reduce complexity and cost by offering simple but important gesture control for broader use. A novel photodiode array ASIC integrates optics, a photodetector array, and an AFE as shown in Figure 2.

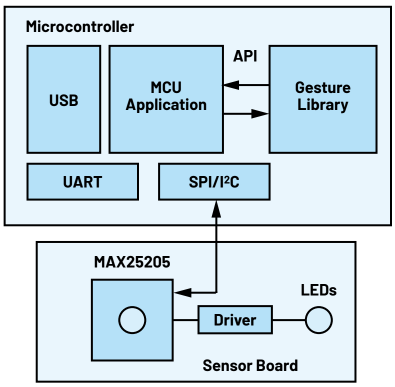


*Figure 2. An integrated gesture sensor system.*

The integrated gesture sensor connects to a simple microcontroller via SPI or I²C bus for the recognition process. This integration is enabled by a proprietary optical QFN package (4 mm × 4 mm). Figure 3 shows the entire ensemble, including the sensor photodiodes on board the ASIC along with optical filtering.

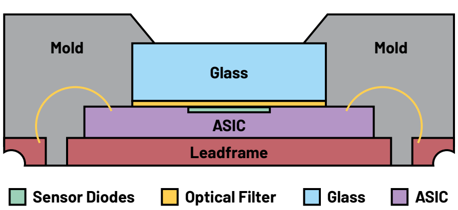


*Figure 3. Integrated optics and AFE cross-section.*

The sensor array has to be protected from solar irradiance. At 940 nm, there is a dip in solar irradiance from $H_2O$ absorption in the atmosphere. This is where the sensor operates. An optical high-pass filter eliminates all solar irradiance below 875 nm (Figure 4).

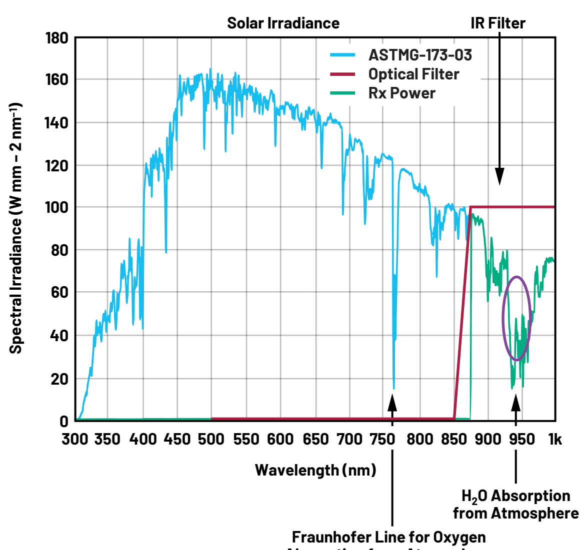


*Figure 4. Protecting the sensor from solar irradiance.*

Four 940 nm IR LEDs illuminate the target. The reflected light is sensed by a 60-pixel sensor array on board the ASIC, which also incorporates all the necessary signal digitalization and control (Figure 5).

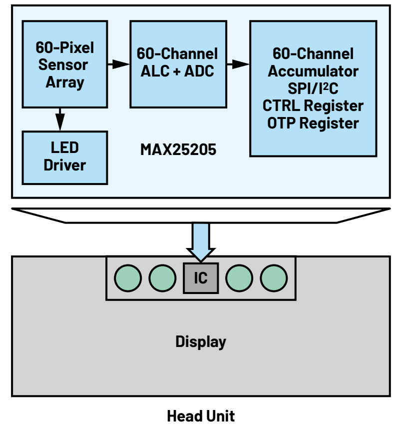


*Figure 5. Integrated gesture sensor ensemble.*

## Integrated Gesture Sensor Operation

The aperture shown in Figure 3 includes a hole in a layer of black proprietary coating that limits the light intake. The quasi-pinhole camera approach, with a large aperture, creates a blob or blurred image, as opposed to a focused image. The 10 × 6 photodetector array captures the entire blob. As an example, the IR-diode array emits a sequence of light pulses of 25 µs duration, each followed by a 25 µs pause. The photodetector array integrates the light during illumination and subtracts it during a pause. Subtracting the latter from the former eliminates the ambient light common mode, resulting in an estimate of the blob intensity. The total conversion period is 20 ms, which results in 50 frames per second (FPS). Each frame is passed to the microcontroller for processing to calculate the vector motion. The vector data is processed, and a resultant gesture event is output by the algorithm.

With a low pixel count (60), this technique allows for proximity and finger tracking, rotation, and other basic but important gestures.

## Application Circuit

Figure 6 shows the MAX25205 simple application circuit. The low cost data-acquisition system for gesture and proximity sensing recognizes the following independent and important gestures:

- Hand-swipe gestures (left, right, up, and down)
- Finger and hand rotation (clockwise and counterclockwise)
- Proximity detection
- Linger-to-click
- Air click
- Wave

A low power, low cost, non-floating-point CPU is required to process the data from the sensor. This can be an Arm® M0 or spare MIPS from another CPU. The BOM for this is minimal—a few filtering capacitors and a discrete MOSFET transistor that drives each IR LED.

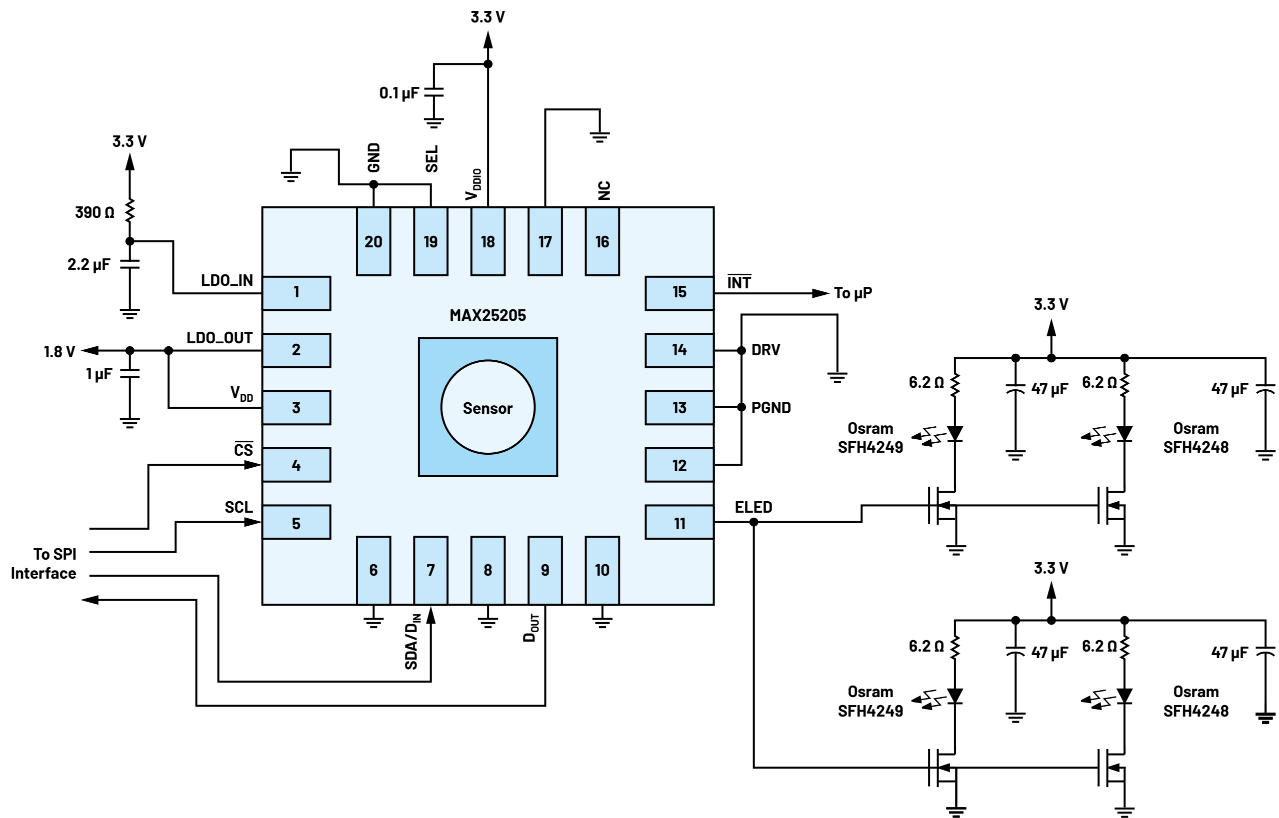


*Figure 6. An integrated gesture sensor application diagram.*

## Conclusion

Gesture recognition improves driver safety and experience. It makes for a cool car experience, without the sting of a high price tag. So far, the high complexity and cost of ToF-based solutions have limited the adoption of this technology to the higher end automobiles. In this design solution, we briefly discussed the limitations of the ToF approach and introduced a novel, disruptive gesture recognition ASIC that integrates optics, sensing, and an AFE in a small, proprietary, optical side-wettable QFN package. The ASIC, in conjunction with an inexpensive CPU, not only delivers gesture recognition with substantially less cost and complexity than ToF cameras but also helps broaden the adoption of this newer technology to a larger class of automobiles and other consumer products.


## About the Authors

Szukang Hsien is the senior director for Analog Devices automotive power solutions. He is in charge of automotive display power, lighting, and USB solutions. Before Maxim, he worked at Texas Instruments for nine years. He has six U.S. patents and has published six technical/conference papers. "Redefining the Possible" is his motto.

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