



Automotive Thermal Sensors: Improving Safety Today and Tomorrow

Tim LeBeau | Seek Thermal
January 2018

Ever since the first horseless carriages hit the streets at the end of the nineteenth century, automotive safety has been a serious challenge. In fact, history tells us that in 1896, Londoner Arthur Edsall was the first driver to strike and kill a pedestrian, even though he was traveling at just four miles per hour. It took the U.S. Congress almost 70 years to begin to legislate automotive safety standards and mandate equipment such as seatbelts and padded dashboards in the late 1960s. Thirty more years passed before airbags became a required safety feature.

The pace of technology over the last thirty years has been astronomical, yet technology to make driving safer has not kept pace. Today driving should be safer than ever, but the reality is that the uncertainties of the road will always be with us. According to the National Highway Traffic Administration System (NHTSA), there were 37,461 traffic fatalities in 2016. In 2015, there were a total of 6,243,000 passenger car accidents according to the Bureau of Transportation Statistics.¹

Pedestrians face their own risks, especially after the sun sets. The NHTSA reports that in 2015, 5,376 pedestrians were killed in U.S. traffic crashes, most often in nighttime or low-light conditions. During the winter months, for example, about one third of pedestrian fatalities occurred in the three hours from 6:00 to 8:59 PM, and overall, 78 percent of pedestrian deaths happened at dusk, dawn, or night.²

Technology In The Driver's Seat

Ultimately, it is safer cars and safer drivers that make driving safer, and automotive designers have deployed every possible technological tool to improve driver awareness and make cars more automatically responsive to impending risks. Today's safest cars are equipped with a plethora and cameras and sensors that make them hyperaware of the world around them and smart enough to take evasive action as needed, but there is still a massive void to be filled.

Advanced Driver Assist Systems (ADAS) are becoming the norm, spotting potential problems up ahead and making auto travel safer for drivers, passengers, and pedestrians—not to mention the more than one million deer that are struck in the U.S. annually, resulting in \$4.2 billion insurance claim. The advances we have seen so far are the first steps to evolving towards a future of truly autonomous vehicles that will revolutionize both personal and commercial transportation.

Drivers need no longer rely on eyes alone to maintain their situational awareness. Early generations of vision-assisting cameras were innovative, but they were not particularly intelligent and could do little to perceive the environment around the car and communicate information that could be used for decision making.

Today, with tools such as radar, light detection and ranging (LIDAR), cameras, and even ultrasound installed, a car knows much more about the environment than the driver does and can

¹ <https://www.bts.gov/content/highway-traffic-fatalities-and-fatality-rates>

² <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812375>

react faster and better to impending danger than the driver can alone. Risky driving conditions—rain, fog, snow, glare—suddenly become far less risky when a driver has so much extrasensory perception at hand, and on-board computers to make sense of all the incoming information.

One of the most important components of current leading-edge suites of integrated automotive sensors is thermal sensing, an imaging system that captures the infrared spectrum just above visible light to read and report the heat signature and heat-related information of anything ahead of the driver. Previously used mainly for military and commercial applications, early forms of night vision first came to the mainstream automotive market in the 2000 Cadillac DeVille, albeit at a cost approaching \$3,000. Since then, thermal cameras and sensors have gotten smaller and lighter and are finally dropping in price. After years of being available only in luxury models, they are now ready to take their place among other automotive sensors to provide a first line of driving defense that reaches far beyond the range of headlights.

Improving Safety Today

Like all other automotive sensory systems, the goal of thermal imaging is simple: to give drivers information about their surroundings and help them react quickly—sometimes automatically—to potential hazards. It joins other sophisticated systems such as long and medium-range radar, which are responsible for a hugely beneficial set of safety features including lane-change assistance, blind-spot detection, cross-traffic alerts, brake assistance and collision avoidance, and adaptive cruise control. Equally useful and popular: parking assistance enabled by ultrasound technology.

What makes thermal imaging so compelling is its ability to help drivers make split-second decisions at high speeds and in every imaginable lighting and weather condition. Thermal cameras know what is ahead because unlike conventional cameras or radar, they can identify the unique heat signatures of a human or animal by reading and evaluating the infrared energy they emit. The camera is looking for heat, and it can see it day or night. While a driver's view may be obscured by darkness, glare, smoke, fog, or oncoming high-beam headlights, thermal imaging sees right through those obstacles and any other visual clutter to report back and help prevent collisions. A deer in the headlights? With thermal imaging, you know about the deer long before your headlights—and your car—hit it.

How is that different than long and medium-range radar? Radar detects objects but cannot identify them without the aid of a visual camera. It knows how far away an object is and how soon a driver will collide with it, but its relatively low resolution means it cannot work as a complete solution on its own. In fact, that is why auto manufacturers typically install separate radar systems for separate tasks, one for adaptive cruise control and one for emergency braking, for example.

A Clear View Ahead

Thermal imaging not only sees better, it sees further, much further. At night, for example, headlights typically illuminate road conditions up to 450 feet away. Thermal sensing can detect

human-sized objects up to five times further, in other words, up to four tenths of a mile, which gives both ADAS and drivers much more time to react, a full 24 seconds at 60 mph.

It is this ability to detect objects that makes thermal imaging shine. Is the object at the side of the road a human, a horse, or a haystack? Is it likely to move or not? Processing the heat signature through an algorithm gives an instant read on the situation in a way that no visual camera or radar system can accomplish on its own, especially on winding secondary and tertiary roads where frontal visibility lessens and the risk of unexpected obstacles increases. Some luxury models will even automatically swivel their headlights in the direction of the detected object.

Soon, anyone can obtain the thermal sensor advantage. Seek Thermal's high-resolution thermal imaging camera, for example, integrates with both new and after-market automotive systems, making it easy to add thermal imaging to any vehicle at an accessible price point. Inside a hermetically sealed housing, a next-generation infrared thermal imaging sensor helps drivers instantly identify people, animals, and nearby vehicles, even in complete darkness. It can process more than one million temperature readings per second to power its instantaneous thermal display. Its 320 x 240 high-resolution thermal sensor delivers 76,800 temperature data points for maximum image clarity and sensitivity. Its 24-degree field of view dual-element chalcogenide lens is optimized for detecting potential hazards down the road.

Autonomy Requires Thermal Imaging

As advanced as ADAS are today, they will become exponentially more critical once they are used to guide truly autonomous transportation, the kind of no-hands driving that is quickly moving from science fiction to science fact. Naturally, there are safety concerns around the idea of minimizing human control in driving, but rapidly increasing power and perception of sensors of all kinds is slowly but surely alleviating those concerns.

There is no doubt that government regulations will require all sorts of system redundancies before autonomous cars can take to the highways. Thermal imaging will be crucial in addressing that need by aiding reliable decisions within the autonomous car's central computer. Price will also be a gating factor. Visible cameras, radar, and ultrasound have plunged in price over the years, making them nearly ubiquitous in new cars today. Thermal imaging is riding that price curve downward as well, and with thermal sensors and cameras now becoming as small as a matchbook, installation is increasingly cost-effective as well.

Thermal imaging has a huge role to play in bringing autonomous cars on the road as soon as possible. Human-equivalent (or better) perception can only be achieved if multiple sensors work in concert redundantly. Forward-facing radar or cameras, for example, are only as useful as the depth of their vision. Should they fail or become blinded, autonomous driving suddenly becomes unsafe. By pairing these sensors with the extended vision of thermal imaging, an autonomous vehicle can more accurately identify the obstacle ahead and trigger the braking system. With these features autonomous vehicles can drive as safely, or even more safely, than humans can. Working together in both daytime and nighttime conditions, thermal imaging combined with radar or LIDAR can address every type of visibility scenario.

About Seek Thermal

Seek Thermal engineers and manufactures low-cost, high-resolution thermal imaging cores for commercial, consumer, and IoT applications. Founded by industry pioneers who spent 40 years advancing the state of military and professional-grade thermal technologies, Seek Thermal has developed a break-through line of OEM thermal cores in a small, market-leading size footprint. Designed for small form factor, lightweight and low power consumption applications, Seek Thermal cores deliver high-end thermal capabilities, accuracy, and performance to enable many new applications and products.