

# Velodyne Lidar<sup>®</sup>



# LIDAR-BASED SECURITY SOLUTIONS

White Paper

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Emerging perception and data technologies are converging to deliver improvements in public safety, security, and efficiency. New solutions promise to enhance threat detection and traffic management in areas including airports, transportation and energy infrastructure, as well as retail, corrections, and private facilities. As implementation of smart security and monitoring systems increases, it is ever more valuable to understand the relative strengths and weaknesses of the various sensor technologies currently available to solution integrators.

Until recently, most security and monitoring systems have been designed primarily around camera technology. Because the duty of monitoring camera systems is both labor intensive and tedious, only a tiny percentage of security footage is ever viewed by humans. As a result, camera-based systems function primarily as either a deterrent to bad behavior or as a record to be accessed after an incident. Therefore, there is clear need for an alternative technology that actively monitors environments and accurately alerts security professionals to an actionable event.

As alternative sensors come onto the market, additional weaknesses of camera-based approaches become more apparent. For example, cameras provide images in two dimensions, without depth measurements, and can suffer in low light conditions. In contrast, lidar sensors provide real-time distance measurements of surrounding objects in all lighting conditions. Cameras are also prone to optical illusions; for example, when target objects have low visual contrast with background scenery or when shadows stretch across a scene, producing costly false negative or false positive readings. However, because it acts as its own light source and does not depend on image contrast to detect objects, lidar does not have these problems.

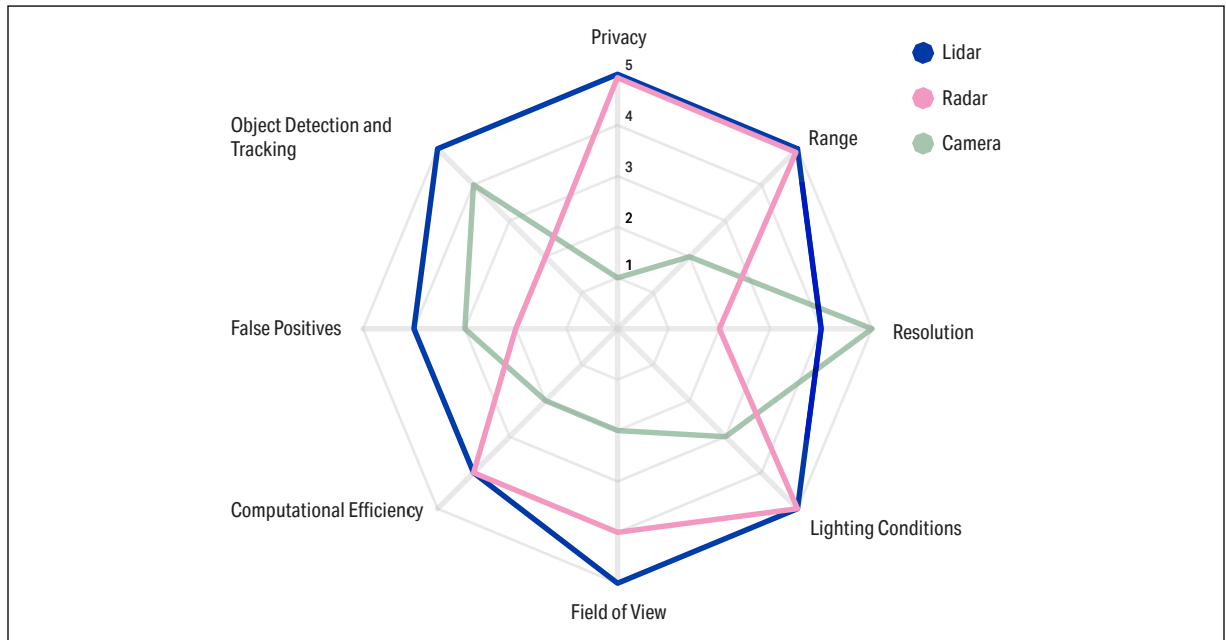
Some security systems employ radar to cover these weaknesses in camera technology. However, radar's resolution, or image clarity, is relatively poor compared to lidar. In low light or low contrast scenarios where cameras struggle to detect and classify objects, radar is therefore unable to adequately step in to perform these tasks. Common scenarios such as these require another type of sensing technology to deliver a different kind of data. Velodyne's lidar technology provides security systems this alternative high-resolution data, enabling object detection, classification, and tracking in all lighting and background conditions.

One strength commonly associated with cameras in comparison to lidar is cost. However, when we consider the total scope of system components required to achieve optimal levels of performance and perception coverage, along with the added operational efficiency of lidar-based systems, this assumed advantage of camera-centric approaches diminishes greatly. A single lidar sensor can provide a full 360-degree view of the surroundings with a range of 100 m. Even more, the data provided by lidar within this field of view is always "in focus"; that is, perception within one part of the scene does not sacrifice focus within other parts of the field of view. In contrast, at any given time, cameras are limited to certain focal distances. Developing a camera system that perceives all relevant ranges simultaneously therefore requires multiple cameras, introducing added complexity and expense. In contrast, our security integration partners report that one lidar sensor can more efficiently cover the area of multiple cameras in security applications. This can significantly decrease the implementation and operational costs over a camera-based security system.

A lidar-based security solution provides additional efficiency and simplicity benefits over camera-based approaches. Utilizing higher-quality lidar, which generates denser point clouds at longer ranges, enables reliable and consistent object detection and tracking with even fewer sensors. Additionally,

lidar data is much faster and simpler to process than camera images, thus requiring less computing power and increasing operator monitoring efficiency. Lidar point clouds also enable customizable and non-physical boundaries. After detecting a defined perimeter breach, lidar-based systems can accurately classify and track objects, thus eliminating the time, cost, and inconvenience of false response monitoring.

Lidar provides another key advantage over camera-based systems in security applications: privacy protection. With increased concerns that facial-recognition technology will be used for general



surveillance,<sup>1</sup> a system that utilizes lidar as the initial source of object detection data enables a security solution that preserves trust and anonymity. This is especially important in applications involving the general public, such as retail monitoring and queue management.

## SUMMARY

In sum, a lidar-based security solution delivers the following benefits:

- Real-time distance measurements (3D perception)
- Object detection and tracking in all light conditions
- Increased signal-processing and automated detection efficiency
- Decreased false positive/negative readings
- Superior perception coverage for simplified and less expensive installation
- Privacy protection

By providing reliable object detection and tracking day or night, Velodyne's sensors decrease the number of false positive and false negative readings to facilitate effective threat response. In security applications, lidar also preserves privacy while improving the efficiency of system implementation and performance. Velodyne's sensors deliver powerful monitoring and protection in a range of physical environments where lidar's real-time distance measurements allow for instant, accurate boundary monitoring.

1. <https://www.aclu.org/issues/privacy-technology/surveillance-technologies/face-recognition-technology>