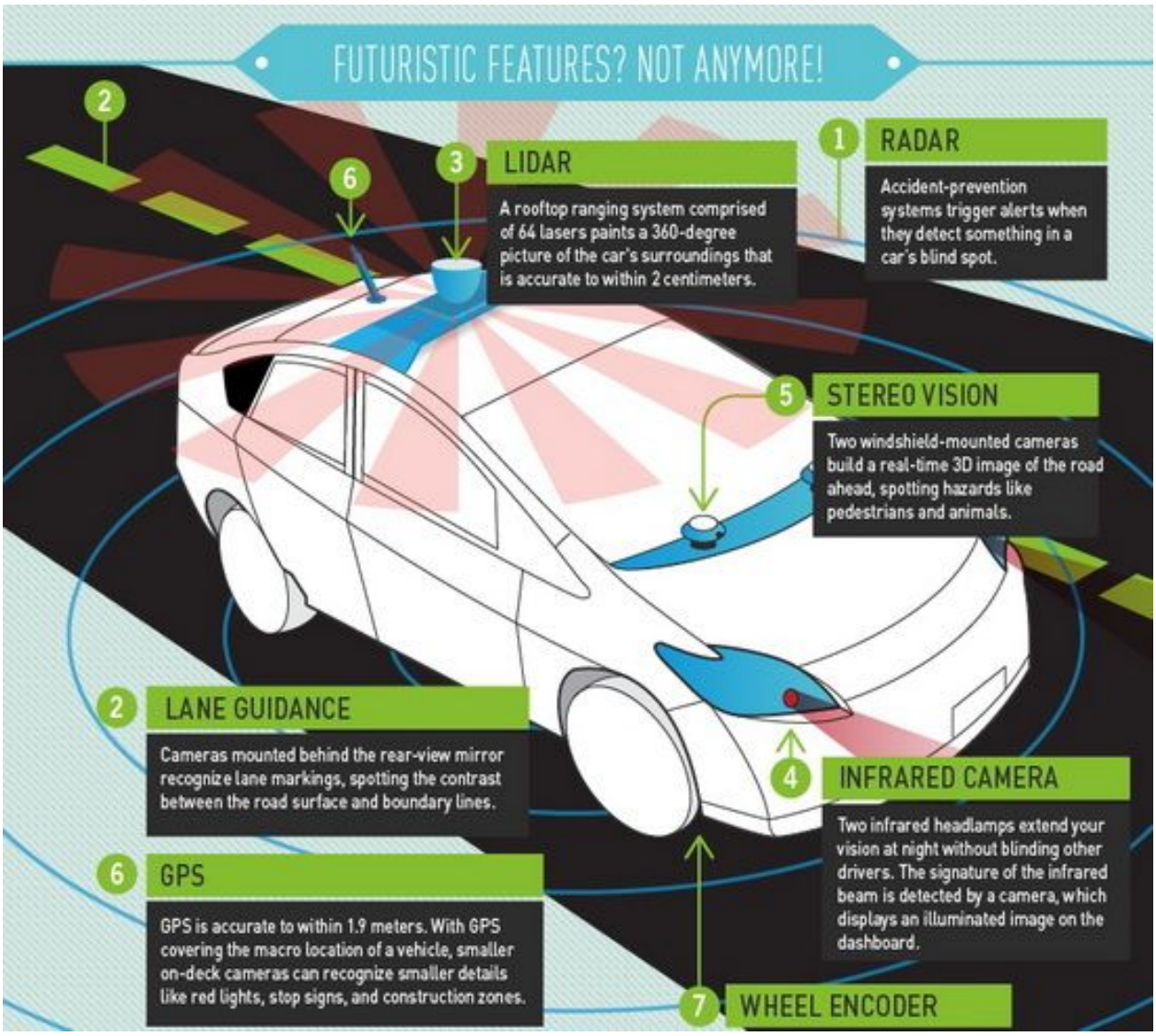

LiDAR Technology and Autonomous Vehicles

A LinkedIn Posting by Jeff Kent

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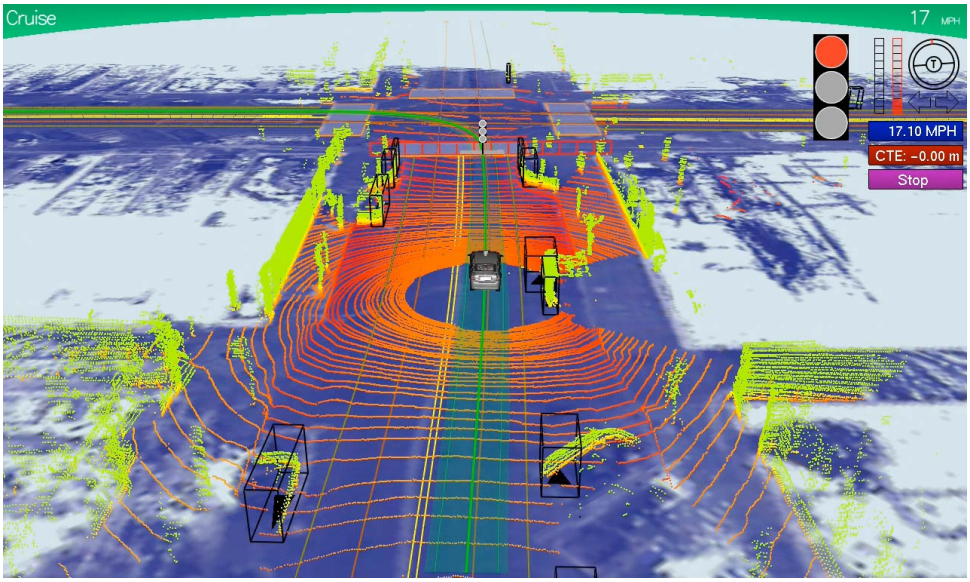
Technology used in various kinds of sensors has really accelerated in the last decade thanks to creative genius and in part, Moore's Law. Sensors and their various components are *smarter*, smaller, lighter, use less power, cheaper and more capable of doing the things we can dream up than ever before. Here's a great innovative example.

1. What is LiDAR Technology?

The name LiDAR refers to *Light Detection and Ranging* or light and radar. It was developed back in the 60's for use in meteorology in order to measure clouds and naturally found its way into great military uses. LiDAR's remote sensing technology measures distance by illuminating a target with a pulsed laser beam and then analyzing the reflected light. Its like having radar on laser beams instead of radio waves. The system obtains target distance from measuring the length of time it takes the pulsed beam to "bounce" back to it; between the producing laser pulse and the echo (rebound) pulse.



2. LiDAR Applications:

Some of the more useful applications of LiDAR are in meteorology, architectural surveys, military, space exploration, robot vision, precision guidance, vehicle anti-collision, mining and wind farm optimization. A direct example of using LiDAR is in Waterloo Regions' Clearpath Robotics' unmanned vehicles, like their new "OTTO" material platform transporter, which uses LiDAR at the front and rear. Varden Labs, in

collaboration with the University of Waterloo, uses LiDAR technology and GPS mapping for their experimental autonomous golf cart project, which would not be autonomous without it.

3. Spinning Multi-Beam LiDAR:

California based Velodyne, developed the spinning multi-beam high-definition LiDAR unit that sits atop autonomous vehicles (AVs). Their 64-laser unit HDL-64E, has an accuracy of about 120 metres and can spin up to 900 RPM (600 is default) and can take over one million readings per second, which creates a panoramic 360-degree view and detailed 3D map of the surrounding environment. The spinning multi-beam LiDAR allows for continuous acquisition of 3D point clouds. The created LiDAR map combines with a Google area map and is analyzed in real-time. With AVs, the LiDAR measures the AVs distance in variable ranges from obstacles, illuminating the target object with a pulsed laser beam then analyzing the reflected light against the detailed area maps. A good example of Velodyne's spinning LiDAR technology is with Google's AV self-driving car project, which uses the 64-beam model on top of the car (coffee can'ish). Velodyne's 32-beam unit, HDL-32E, rotates a full 360-degrees up to 20 times per second and reads about 700,000 points per second. This model is used by Clearpath Robotics and in NASA's Centaur2 and KRex rovers for obstacle detection along with many others' mobile mapping systems (MMSs).

Other AV Things to Consider:

Over and above the new innovative LiDAR systems for AVs, real-time speed and distance of vehicles is determined using wheel speed sensors, front/rear mounted radar and a pair of cameras with overlapping fields of view on each end for tracking real-time distances in 'stereo.' Accelerometers also need to be implemented to detect changes in rotational attributes.

Some companies providing LiDAR sensors/systems right now are: SICK Inc., Hokuyo and Velodyne. Bosch' system is currently under development and expected in a few years.

About the Author: *Jeff is currently in his second term at the University of Waterloo's Master of Business, Entrepreneurship and Technology (MBET) graduate degree program, finishing summer 2016. He recently obtained his Bachelor of Administration in Management degree on the Dean's list and has 13 years of innovation experience as an Automation and Robotics specialist.*

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