Charles Toth
Department of Civil, Environmental and Geodetic Engineering
The Ohio State University, USA

"HOW PHOTOGRAMMETRY AND LIDAR ARE HELPING DRIVERLESS CARS?"

"Charles, what is the state of the art in driverless cars?"

Driverless or autonomous vehicle (AV) technologies are currently one of the hottest topics in research and development, driven by a huge customer market. Traditional car manufacturers, internet giants, and startups are heavily investing in sensor developments and data processing across the developed world. As a result, new stock cars increasingly show growing AV functionalities to support autonomy, already reaching SEA Level 2 (Partial Automation). Photogrammetry and LiDAR have been equally accepted in the mapping community for a long time, though more recently, there is an ongoing race between point clouds created by the two technologies on UAS platforms; in fact, point clouds have become the second fundamental data entity in geospatial science and engineering.

"What is the sensing system of driverless vehicles?"

It generally includes cameras, radar, LiDAR and ultrasonic sensors. However, the competition between the point clouds, generated by photogrammetry and LiDAR, plays out quite differently for AV, as there is a big difference in what is happening in production vs R&D. Most of commercially available AVs are coming without LiDAR sensor for a simple reason: the price is too high. In contrast, deploying inexpensive cameras poses no economic limitations for manufacturing cost, and, typically, 5-10 sensors are deployed on AVs. The R&D field, however, shows a very different picture, as both large companies and startups are working at neck-breaking pace to develop an affordable LiDAR sensor for AV. The capability of LiDAR to directly provide 3D data is extremely advantages for AV technologies where the processing time is extremely critical at normal highway speed. Most current designs are based on scanning solution, which is less attractive for extended use on a highly dynamic platform, but solid-state (Flash LiDAR) is currently less affordable.

To answer the question in the title, the first part is clear, using cameras for AV is indispensable, an absolute necessity, as millions of kilometers, driven in assisted driving mode, have already proved it. Furthermore, as in-vehicle processing power continues to grow, more cameras can be installed to better support specific aspects of AV driving. On the LiDAR side, the affordability is the primary reason why laser sensors have not been deployed in larger quantities. In addition, the range of the current mobile LiDAR systems is generally short; at least for highway speed. Likewise, the spatial resolution decreases with the object range, resulting in sparse point clouds. Obviously, the resolution acts the same way for cameras, but their angular resolution can be higher, so it is easy to achieve high resolution for longer distances. For example, Tesla cars use three forward-looking cameras, optimized to provide similar resolution at 60, 150 and 250 m distances. Both limitations of existing mobile LiDAR system can be eventually overcome. Using longer wavelength, the power of the laser pulse can be increased by orders, so the max ranging can be extended to 250 m. Using smaller scanning elements and variable scan patterns, high point cloud density can be achieved at larger distances.

"…and looking forward?"

There is no doubt that once the mobile LiDAR parameters have improved and the production cost has significantly decreased, the use of LiDAR will be standard on all AVs. The benefits of LIDAR sensors have been convincingly demonstrated by research and in small-scale applications where price is not prohibitive.

Having both sensors on board, the robustness of understanding the vehicle environment can be further improved, resulting in increased safety, the prime reason for AV technologies.