High Density Laser Data with HYSWEEP and Velodyne

By Dave Maddock

It's a good day at the HYPACK offices when you can strap a bunch of equipment to the roof of the van and drive around the neighborhood. The past several weeks we've been doing just that while testing a full-resolution HYSWEEP® driver for the Velodyne HDL-32E laser. Special thanks to Jerry Knisley and Bob Glover of HYPACK support for their help on this project.

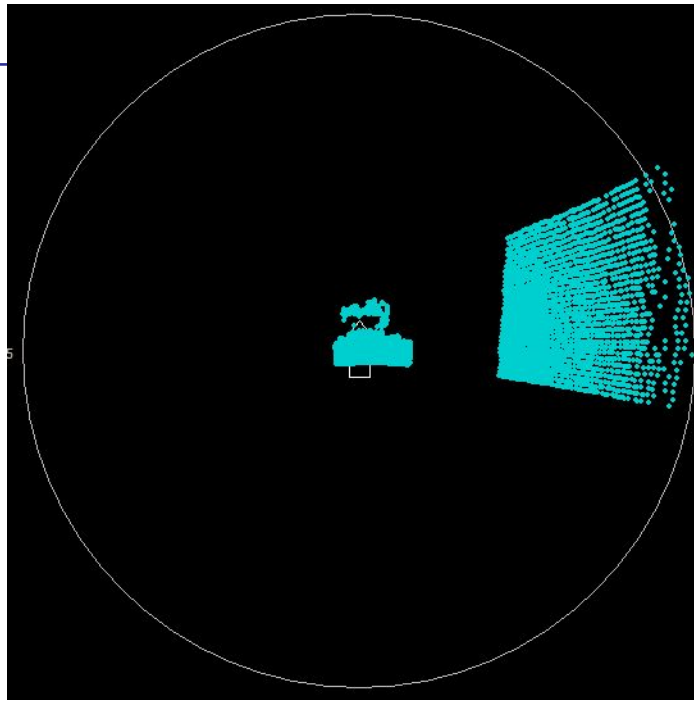
FIGURE 1. *One Mount to Rule Them All: The Equipment Deployed in Minutes, Thanks to HYPACK Staff Bob Glover.*

A Novatel SPAN system was used for positioning and motion correction. All sensors were mounted to a single wooden structure for quick deployment and consistent patch testing across multiple sessions. The laser itself was mounted to adjustable piping which allowed the sensor to be rotated to horizontal, vertical, or 45 degree position. Also included in the rig was a GoPro camera (not pictured), triggered to take photos at five second intervals during logging.

THE VELODYNE HDL-32E

The Velodyne HDL-32E is a LiDAR sensor with a 40° "swath" of 32 beams within a 360° rotating head. It sports a 70 meter range with a ±2cm accuracy and delivers 700,000 points per second. Although HYSWEEP® has supported laser data from various devices for several years now, the 32E poses some new challenges. Existing HYSWEEP® laser drivers are variations on the "2D line scanner" theme. (3D devices such as the Reigl VZ-400 are put into line scan mode at a fixed head rotation angle.) A line scanner reports data points along a plane and the 3rd dimension of the data is provided by the movement of the vessel. The HYPACK® 2015 release includes a simplified driver for the Velodyne that emulates a 2D line scanner by reading only the center beam (the one aligned port-to-starboard).

FIGURE 2. *Caught in Mid-sweep Off the Starboard Side*



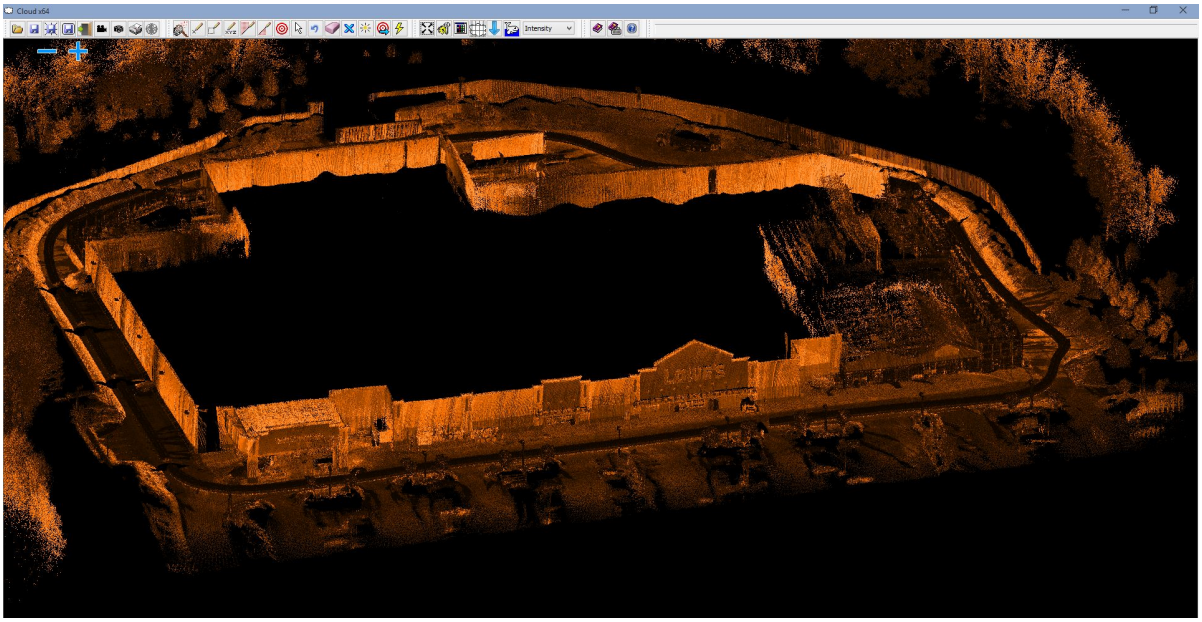
The additional 31 beams are not purely aligned athwartship, but also have a forward component. If mounted vertically, the 40° swath of beams spins around the forward axis of the vessel. If mounted horizontally (as pictured above), the swath rotates around the Z axis. This type of LiDAR data is new for HYSWEEP® mobile acquisition. The sheer volume of points also poses a challenge to log, process, and display everything in a timely manner.

The Figure 2 shows the sweep in action. The forward-most beam has a yaw angle approximately 30° forward. This beam pattern minimizes shadows and insures better coverage around objects. In fact, we had trouble avoiding our own vessel in the process and had to edit out phantom bumpers in post-processing.

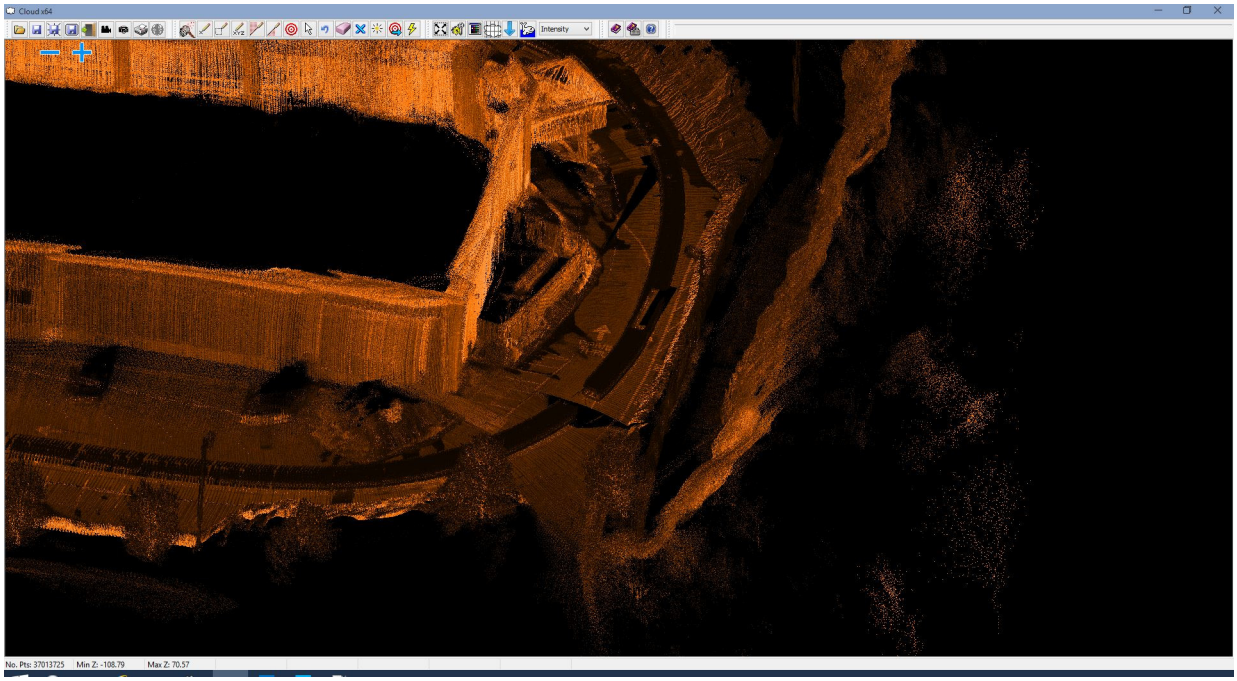
PRETTY PICTURES

Okay, enough jabbering. Let's look at some fun images of what we collected:

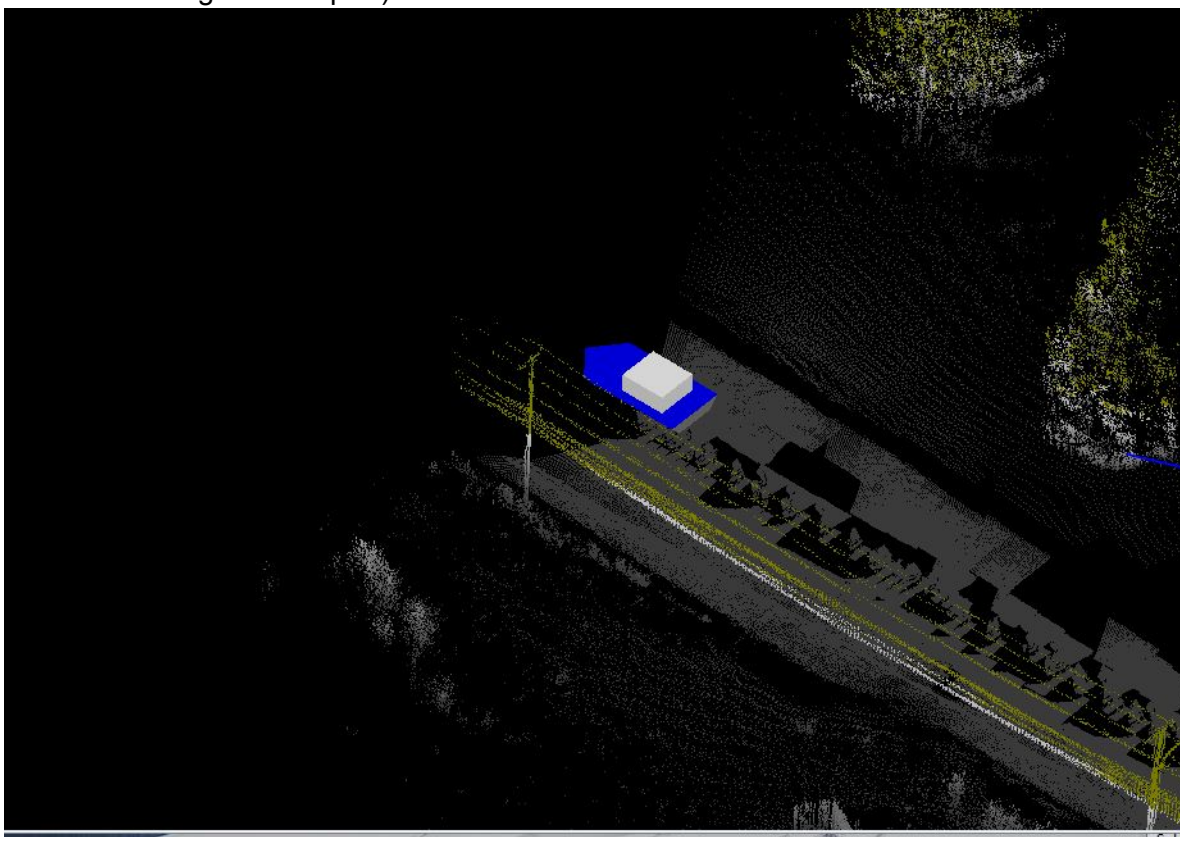
- One pass around our local Lowes. Over 25 million points. Check out the garden center detail captured through the chain link fence. (You can see more in the full resolution image.)



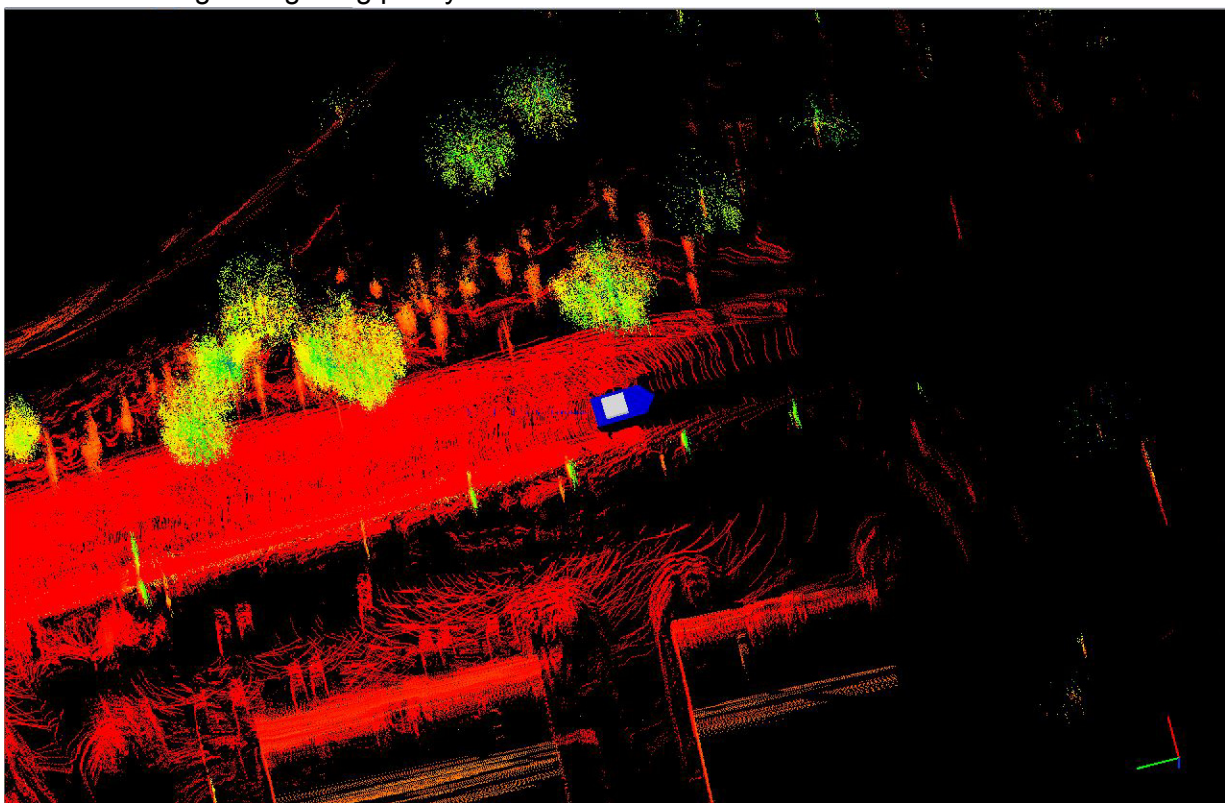
- Here is the drive through pick up window of a CVS. Notice how we can pick out the painted arrow on the pavement by coloring the point cloud using the intensity returns.



- Here are a few shots during acquisition. In the first, we are scanning down the street, picking up trees and telephone lines. (The jumble in the middle of the road is noise from beams hitting our bumper.)



- In this one the laser is mounted horizontally (rotating around the Z axis--can you pick out the circle-pattern?) and we are looking down from above. Notice how the walls between the buildings are getting plenty of hits.



The combination of the data density and additional beams at oblique angles means that the "striping" typically seen with 2D line scanners is wholly absent. The downside is that the datasets are huge. Our one-day test survey around the office neighborhood clocks in around 20Gbs!

This driver and the post-processing updates to support it are still in the development stage, but as you can see, progress is well underway. Stay tuned. My hope is to push our laser support even further, integrating point clouds with photos for RGB coloring and QC/editing support.