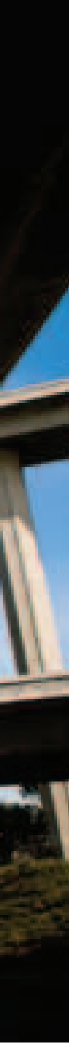
MOBILE MAPPING AND DATA COLLECTION

MOBILE SURVEYING TECHNOLOGY CHANGES THE WAY MANY INFRASTRUCTURE SURVEYS ARE DONE.

Mandli Communications, Inc. is a data collection company based in Madison, WI, USA, that specializes in roadway and highway infrastructure data collection and analysis. While enjoying a thriving, growing business, Mandli was searching for a missing piece in the comprehensive data collection solution. At the DARPA Grand Challenge and later at an industry trade show, Mandli found the Velodyne HDL-64E, a 64-element high-definition LIDAR sensor that is capable of generating a 360-degree HFOV and a 26.8-degree VFOV.

Mandli is an industry leader in the design and development of highly specialized digital imaging and data collection equipment and operational methodologies for Departments of Transportation throughout the world. Since 1983, they have made available to the transportation industry a complete range of imaging, pavement and positioning equipment. Together with a suite of supporting GIS software and services, they enable their clients to design, manage, and maintain safe and efficient road and rail networks.

NOVA's television special on the DARPA challenge was what first brought Velodyne to Mandli's attention. Some of the teams involved in the autonomous vehicle navigation competition relied exclusively on the HDL-64E to gather environmental information used to navigate their vehicles through a simulated urban environment. Mandli, a long time integrator in the field of transportation technology development, saw the LIDAR sensor as a way to make data collection in the field faster, cheaper and safer.



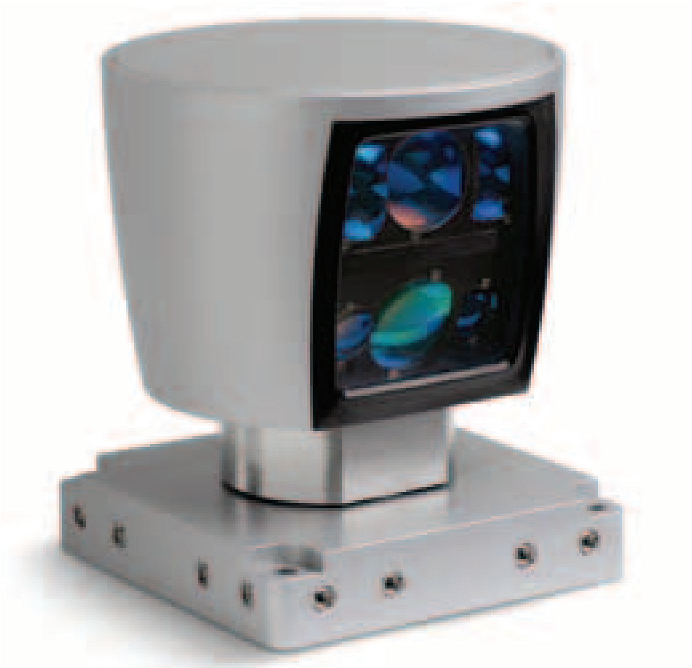


Figure 1. Velodyne HDL64E LIDAR scanner can capture distance data up to 120 m with a full 360 degree field of view.

Mandli's goal was to build a system that would include a vehicle-mounted HDL-64E which would collect data on the surrounding environment at highway speeds. This data could then be used to take accurate measurements of roadway assets and objects, producing results that had never been achieved before. In addition to integrating the new hardware on Mandli's existing data collection vehicle, Mandli needed to develop software new software that would allow them to simultaneously display multiple data scans. This new software would allow them to view and virtually navigate entire stretches of road, instead of having to load single scans showing only partial road sections at a time.

Mandli also had to write new software that would integrate the HDL-64E into their established data collection system, which included photolog images and positioning data. In order to get the system to interpret changes in vehicle position and direction properly, Mandli had to introduce new algorithms into the system that would interpret the roll, pitch and heading of the vehicle as it traveled down the road. GPS data was used to solidify the position of the sensor itself as it navigated through the scanned environment.

Mandli was able to produce a prototype system that could effectively integrate the HDL-64E into its collection methodology. The applications for the new system are wide and varied, ranging from digital terrain modeling to highway clearance measurements to vegetation encroachment surveying. Mandli's software was even able to automate some of the asset recognition based on intensity data returned by the LIDAR system.

One of the greatest assets of the HDL-64E is its potential for increasing the safety of surveyors. In the past, in order for an agency to take the vertical clearance measurements of a bridge, they would have to close down a lane and perform a manual rod survey. This not only endangered the individual who would have to work next to a lane of moving traffic, but put the passing motorists at risk as well. Velodyne's HDL-64E improves this method greatly by capturing the clearance measurements of all lanes in a single pass at highway speeds.

The true test of the new HDL-64E integration came in the form of a request by a State DOT for a demonstration of the new technology. By using the new LIDAR technology, Mandli was able to collect a comprehensive sample set of data in just two days. Turn-around time from data collection to presentation was reduced from what could have been several weeks to several hours. The demo included a three-dimensional representation of the scanned environment built from the LIDAR data. As the roadway was virtually navigated observers could view it from any angle and at variable speeds. Mandli's software was able to automatically display the clearances of horizontal and vertical structures along the road, as well as automatically identify reflective road assets including signage and paint striping. The resulting data collected coupled with Mandli's new software produced results that would have taken several weeks and many hours of man power to duplicate. A fast, cheap and safe solution to roadway data collection had been found.

Figure 2. Mandli Data collection van equipped with LIDAR sensor.

Figure 3. Bridge height measurement taken with Mandli data collection vehicle. Note lane markings visible along with road signs.

Figure 4. Bridge height and other infrastructure position measurements are accurately determined even with the vehicle travelling at full road speed.

Minimum overhead clearance data for bridges is required for the issuance of oversized load permits. In the past the only method to take measurements was a manual rod survey. This involved closing down individual lanes of traffic one at a time, during which individuals had to stand in the road and use a pole to find the clearance of the bridge. This not only endangered the safety of the workers, but it put any passing motorists at risk as well. It was also a very costly process. According to a survey of some of Mandli's customers, the average cost for a single lane closure, including both setup and removal, is estimated to be between $700 and $1,200 per mile for a state highway or freeway, and $400 per mile for a local road. With the HDL-64E, Mandli is now able to collect the clearance measurements of multiple adjacent lanes of travel in a single pass, traveling at posted speed limits, negating the need for any lane closures.

The same principles apply to other services, such as digital terrain modeling. Instead of using a stationary system that must be often moved and re-calibrated to take new measurements and cover a large area, the HDL-64E allows Mandli to collect data over a large area in a short amount of time. This produces a model that rivals the accuracy and reliability of stationary collection methods, while proving to be much safer and cost-effective.

The HDL-64E fit in well with the data collection system Mandli already has in use. The system features between one and three high-resolution cameras, depending on the project. The camera are mounted inside the collection vehicle and collect right-of-way images of the roadway. The view of the cameras includes guide signs, roadside features, billboards, vegetation and terrain. Dual GPS receivers and antennas are mounted onto the roof to give positioning data, as well as aid the inertial data, allowing the system to derive useful aiding information from even a single visible satellite. An Inertial Measurement Unit is included to work with the GPS to produce distance data, as well as provide a position and orientation solution, guaranteeing the accuracy of the collected data. Information provided by a Distance Measurement Instrument gives a measure of the vehicle's linear distance traveled, and is used to constrain errors in vehicle velocity and displacement. Depending on the project, the Mandli collection system may also contain equipment for taking pavement measurements, including high-resolution images, longitudinal profile elevations, International Roughness Index (IRI), slab faulting, texture and rutting measurements.

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