# The Automated Drive South: Highlights & Observations

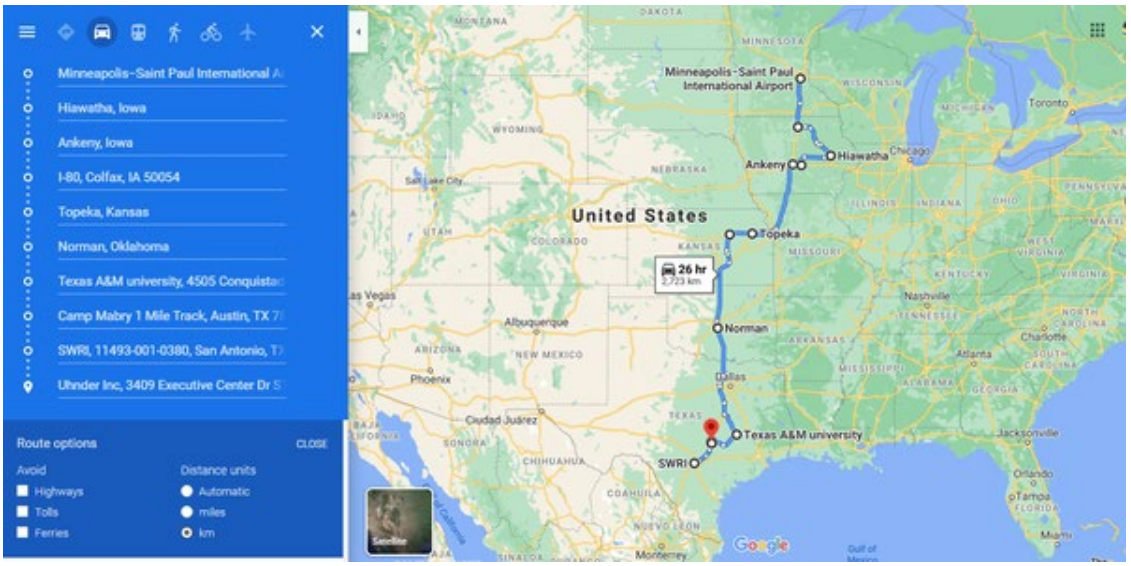
**By Phil Magney**

VSI logged over 7,000 miles with our research vehicles last month. The journey was part of our Drive Series Program, which includes a number of quarterly cross-country drives. Called the Drive South, VSI Labs hit the road last month bound for Texas but with multiple stops along the way.

While the Drive Series program has many objectives, the primary focus is the functional examination of ADAS/AD enabling technologies. The Drive Series Program offers vast exposure to scenarios, environmental, and road conditional data that serves as a good proxy for representative real-world operating conditions. Both research vehicles are enabled with by-wire and full telemetry functions whereby we can record all inputs including those coming from the CAN bus.

VSI vehicles are equipped with massive on-board storage facilities that can store many terabytes of raw data. The data is so large that each day the contents must be transferred to our AWS servers to make room for the next day.

Like all Drive Series events, last month's drive included stops to visit customers or other interested parties including state DOTs. We met up with Iowa, Kansas and Texas DOTs as well as OU, Texas A&M and the Southwest Research Institute.



The purpose of this report is to shed some light on a few of the key findings. Specifically, we would like to make some observations about automated lane keeping using the latest technology stack from Trimble and Ushr. This solution is already found on the GM Supercruise but the version VSI represents is the latest version of this.

We also discovered some interesting sensor performance issues while driving in heavy rain. The only sensor that could handle the conditions was a NIR solution from Bright Way Vision. Furthermore, VSI uses real time friction analyzers to detect areas of low grip. Using software from Nira Dynamics, we were able to see the correlation between visible conditions and slippery conditions.

## Map-Based Lane Keeping

VSI Labs has developed a highway automated lane keeping system using absolute localization leveraging correction services fused with High Definition (HD) maps. This ADAS system was integrated in the VSI vehicle utilizing Trimble's INS device with precise point positioning (PPP) technology called Trimble RTX (Module BX992) and precision lane models coming from USHR's HD maps.

Primary limitations of vision-based lane keeping systems such as poor markings or inclement weather conditions can be solved using HD maps that provide information on current and surrounding lane topology to a high degree of precision. VSI encountered many roads with poor lane markings that this technology was able to overcome. VSI utilized the newly integrated lane keeping system to reach the target destination while driving through several states including Iowa, Kansas and Oklahoma. Furthermore, the system worked well even with adverse weather conditions such as torrential rains.

There was never a time when the Trimble device was unable to connect to corrections or get an RTX fix. In the past, VSI had to do extra driving to make other systems work, such as real-time kinematics (RTK). RTK uses a ground-based position technology which was used in the VSI vehicle as a correction service before Trimble's arrival.

VSI's lane keeping controller kept the vehicle centered in its lane by calculating a steering command that points the vehicle towards a lookahead point some distance ahead, and uses the precision lane model to actively center itself in the lane.

Even though there were some unavoidable limitations such as construction zones or occasional loss of correction, the coupled system with Trimble's absolute localization and USHR's HD maps performed reliably. Trimble's system dead recons with such precision that the performance in dense highway infrastructure was impressive.

## Adverse Weather Conditions

VSI's primary vehicle was equipped with four different cameras to record and stream data during the Drive South. These cameras included a long-wave infrared thermal camera, two visible cameras, and Bright Way Vision's near infrared (NIR) camera.

All the cameras worked well in normal weather conditions during the drive until the vehicle encountered heavy rains. Following pictures illustrate the behavior of each camera during a thunderstorm on I-35 near Justin, Texas.


The NIR system from Bright Way Vision yielded performance unlike anything we have experienced thus far. The visible cameras (#1, #2) represented human eyes while the NIR camera could see through the dense rain. The thermal camera works well in this environment too but heat signatures are less detectable in these conditions.

## Behavior of Radar & Lidar

VSI's vehicles are equipped with several additional lidar and radar sensors. The lidar is mainly used for ground truth while the radar is used for object detection and tracking. Lidar is vital to ground truth when performing research like this.

As expected, both the Lidar and radar were affected by the heavy rain. Lidar picks up lots of noise while the radar suffers from false positives. Then there is the accumulation of bugs and other road debris on the sensors themselves. Bug removal is tough for most

sensor cleaning solutions!

## Real-Time Road Surface Monitoring

VSI works with NIRA Dynamics to monitor the road surface friction along with the road roughness (IRI) without using any physical sensors. It uses wheel speed sensors that are already available in the car to continuously calculate the friction between the tire and the road. Before the implementation of NIRA technology, VSI was using static values for coefficient of friction on dry and wet asphalt. But after NIRA got on board, VSI was able to use instantaneous road surface friction values in order to dynamically adjust outputs to the control systems.

## Conclusion

Having spent the last week on the road really opened our eyes to the importance of active ADAS features. This includes a variety of LKA, AEB, ACC, BSD, CTA, and highway autopilot applications. It appears these ADAS applications will be a driving force in production cars in the decades ahead. Cross country driving will be around for a long time and this will not give way to robo-taxis any time soon! But with that said, advanced ADAS features with autopilot functionality will become nearly standard equipment before long. These technologies can substantially heighten the safety and comfort of roadway travel.

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## About VSI Labs

Established in 2014 by Phil Magney, VSI Labs is one of the industry's top advisors on AV technologies, supporting major automotive companies and suppliers worldwide. VSI's research and lab activities have fostered a comprehensive breakdown of the AV ecosystem through hands-on development of its own automated vehicle platform. VSI also conducts functional validation of critical enablers including sensors, domain controllers, and AV software development kits. Learn more about VSI Labs at https://vsi-labs.com/.

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