TRANSPORTATION TECHNOLOGY

Utah Connected Webinar Series: Webinar #6 Questions & Answers

UDOT deployed two automated vehicles to evaluate the compatibility of Utah roads with connected automated vehicle technologies, specifically Lane-Keep Assist (LKA) and Advanced Driver Assistance Systems. Each vehicle was equipped with a full suite of automated driving sensors, such as advanced camera, lidar, radar, and positioning systems. The vehicles were driven on different roadway segments throughout the state to record data from the automation sensors. The objective of this webinar was to highlight the study findings, explain which automated technologies worked best on certain roadways, and identify challenges and opportunities for other DOTs to consider in future deployments. Some of the key takeaways included:

- Connected Automated Vehicles (CAV) are bringing Utah one step closer to zero fatalities on roads and full situational awareness.
- Vehicles today have already implemented some of the sensor technology we need to accurately identify road features and markings.
- Utah's lane markings are usually adequate for machine readability, but some locations need improvement to increase technology readability and overall performance
- AI is evolving and adapting to help with lane detection.
- Misdetections are found due to road glares, surface changes, extreme curvatures, shadows, and scarring. Improved lane markings and automated vehicle cameras can help overcome these misdetections.

Q1: I recently saw on online debate of whether ALKS is a true level 3 feature of not. Given that the UN Regulation 157 has detailed so much on ALKS, will the SAE amend J3016 further to reflect choices or levels on this feature in more detail?

A1: ALKS is a function of level 3 performance; it is lateral control, and on a level 3 system, it is going to rely on both lane markings and vision systems. Then, it's most likely going to have a high-definition map that includes virtual markings within the brain of the computer, a redundant method of positioning itself.

Q2: Who actually owns the data collected by VSI? Does UDOT have to pay to access it?

A2: According to UDOT's contract with VSI Labs, UDOT owns the data that was collected. However, UDOT doesn't possess the data that was collected. After Phil's team collected all of this data, we didn't have a place to put it or a real use for the direct data, so what Phil has provided to us is a portal that we can log into and get access to that data in its process form at no cost. Maybe someday we'll make it available as an app.

Q3: Do the AV vehicles read speed limit? What happens when it reads a road like US 301? I have a 2023 model car, which is capable of adaptive cruise, but it reads US 301 and tells me the speed limit is 301 mph.

A3: If the speed you are referring to is in the map of the vehicle, there should be an associated posted speed limit there. In Europe, there is a new regulation called intelligence speed assist that automatically sets every car sold in Europe with the ability to know the posted speed in the area it's driving through, and this intelligence is highly likely to make its way to America.

Q4: Is the car shown in Phil's presentation a level 4 or 5 AVs, or is this a regular car with LIDARs, sensors and cameras?

A4: That vehicle is theoretically whatever you want it to be, but the vehicle shown in Phil's presentation specifically was a by-wire development, normal vehicle that had a whole suite of sensors gathering data. Although the sensors on the vehicle could possibly enable full self-driving (level 4 kind of operations), the vehicles were being driven by a human at all times, so at no time were these vehicles driving themselves; it was essentially a simulation.

Q5: What is the role for V2X technology in supporting autonomous driving?

A5: Some automated vehicle developers feel that they can't rely on V2X data, but UDOT believes that V2X has a huge role in making automated vehicles more successful. Automated vehicles operate based on what it can see, and the sensors on board the vehicle are seeing things around it, which the automated vehicle responds to. However, it can't see everything, so the beauty of V2X is that we can tell the vehicle things that it can't see and allow it to operate itself based on what it can learn about the environment around it. Automated vehicles are being developed by vehicle manufacturers without V2X technology, so as agencies working on the roadside, we need to step up and deploy connected vehicle technology, demonstrating it can be done.

Q6: Will there be more testing on busy/active urban and downtown streets? (Utility disruption and patching; new types of bicycle lane markings and bollards, etc.)

A6: Eventually, yes, but for now, testing will generally be done in rural areas and on main roads until the sensor technology becomes more advanced.

Q7: Did you look at how the technology performed in work zones?

A7: Although VSI Labs doesn't condone the use of automated technologies in a work zone, if those work zones are well marked, the system can read those temporary markings just fine. However, lane scars become an issue. It's not recommended to use automated technology in these work zones.

Q8: How does the system based on open-source software used in this study compare performance-wise with LKA systems provided by OEMs?

A8: The problem with everybody's LKA system is it's a black box; that's a problem with AI systems in general. You really have no idea what is causing it to do what it's supposed to do or what it's not supposed to do, so it's extremely difficult to try and decompose an OEM solution other than a side-by-side comparison. VSI's "benchmark vehicle" is Tesla, and both the state and Tesla vehicles have been tested on 2.0 autopilot, comparing the LKA systems, and we VSI thinks UDOT's detectors are as good if not potentially better than Tesla's. The latest generation of lane centering assist, which is available in pretty much every OEMs lineup now, is going to have the best state-of-the-art performance.

Q9: AI is a hot topic these days. With the AV industry as an early adopter of AI, what recommendations do you have on how to best leverage AI in potential future deployments? What are best practices to employ? Conversely, what are lessons learned that you'd recommend they NOT do with AI?

A9: These systems are built on video analytics; a lot of systems in our lives today are built on video analytics such as security cameras in airports and cell phones. UDOT has terabytes of data from their studies, and with AI, UDOT can begin to sort through that data and find trends and useful information. Also, AI has a huge potential to improve the capability of recognition of images or video, so to keep moving forward, training of these AI technologies is important, giving them more examples of what images look like. AI is great for use if you're trying to detect and classify with confidence. One of the challenges with automated vehicles today are that they they can't identify everything they see, and AI will eventually be able to help us solve that problem. For now, there is no generative AI reading roads.

Q10: Did the survey capture any rumble stripe use cases for centerline or shoulder markings?

A10: The survey did capture rumble striping on I-15 and I-89 down the center line. On top of that, the paint was applied to the right of that line, so the combination of those two things actually improve the performance of the detector. If that lane is solid, it's going to work well whether that rumble strip is there or not. However, if the striping begins to fade a little bit over time, that rumble strip will extend the longevity, or the readability, and if you just had rumble strips, the vehicle would probably do just fine because it would detect the lines again, as long as the algorithm was previously trained for it and would be able to maintain full lateral control.

Q11: If an AV is operated in a geofenced area (scanned and mapped prior), will lane marking still play a role in AV operation?

A11: The simple answer is no. The vehicle has to have a way to localize, and it is unfortunate the today's GPS capability is not precise. Geofencing the application is going to restrict its operating domain within an area. It could restrict it to a geographic area or a road type, and that's how the industry generally applies that terminology within the context of operational design domain, describing where it can and can't be used. You would need a high performance GNSS device like with a RTK system. However, with a software-defined vehicle, you can automatically flash the algorithms in those vehicles to introduce new performance capabilities and features. Tesla is a great example of this.

Q12: Have you used any of the camera data to analyze pavement conditions in addition to lane marking conditions?

A12: That wasn't UDOT's intent here; it was really to look at whether or not their infrastructure supports ADAS features. UDOT has had other projects where they have proposed to look at pavement conditions in real time, and there are some commercial products out there that do that. Frankly, as UDOT started looking at that, their maintenance engineers said that they don't really need that information in real time because they have good sources for that information on their periodic surveys already. Every other year, UDOT does a complete LIDAR scan of all of their state highways, and that informs their asset management process, looking at things like conditions of guardrail, signage, etc.

Q13: Most of your examples are in rural areas, how well do they work in highly congested urban areas?

A13: Because Utah is a big state with long roads, a lot of them are in urban areas. Utah is a very urbanized state with about 1 million of the 3.5 million total population living along what we call the Wasatch Front, a narrow 70-mile stretch of land. The AV technology was just as effective there as it was in rural stretches long as the payment markings were adequate.

Q14: is there any thought about modifying standards, such as increasing width of stripes or encoding stripes in some way to differentiate whether exit lane, center lane, etc.?

A14: There is a lot of discussion today about modifying standards; FHWA is about to issue a new version of the MDTCD. Many states, including Utah, have gone to six-inch stripes on key interstates instead of four-inch stripes as it turns out to be better for humans to read. What UDOT found in this particular study, though, was that the issue wasn't so much the paint width as it was the marking quality and contrast; the tiger tail stripe, for instance, on concrete pavements where you've got alternating white and black stripes on gray has proven to work really well and enhance the ability of the system to pick up paint stripes. The new MDTCD shows a short dash, or a dotted marking if you will, across turn lanes to solve some of the problems that Phil talked about in his presentation.

Q15: It seems with the results of this kind of research, codes and standards for state DOTs (and federal DOT) for lane markings, etc. might make sense. Are you headed in that direction?

A15: Blaine is involved in some SAE standards right now, and it's a multi-year process to consider and gain consensus. The MDTCD just went through that kind of a process over about a 5-year period where they looked at some of these pavement marking issues, studies, and efforts that were involved, and they have recently provided a transportation operations manual that has a chapter on connected vehicles and automated vehicles. Some of these comments are in there. It's sort of an evolving practice, but it pushes UDOT to absolutely consider these results as transportation and vehicles change to make sure we're moving forward appropriately to support these kinds of technologies.

Q16: What are the best practices or principles that peers should consider when it comes to the costs associated with a deployment like this?

A16: UDOT originally entered into an agreement with VSI Labs through what we call an experimental procurement to try something out and paid them to come in and survey first about a thousand miles of road and then a second time through about 600 miles of road. To be perfectly honest, I don't remember what we paid for that, and it's probably different than what someone else would have paid. As Phil has described really well, the system they have developed has evolved significantly, and some of what was done in the first survey has been improved and automated a lot. There's a lot of capability there, so whatever we may have paid for it is probably not representative of what you pay for today.