Using Technology to Make Smarter Roads

Smart roads and mobile mapping are helping to improve road safety.

BY DON TALEND
The Virginia Smart Road provides four seasons in one day—literally. The 2.2-mile (3.5 km) two-lane road creates realistic weather conditions through its state-of-the-art technologies. It provides rain, snow and fog on demand, and serves as a testing ground for an array of vehicle-related attributes such as variable lighting, pavement marking and signalised intersections. It also provides a platform for testing a variety of technologies such as differential GPS and new weather information systems. Smart Road is managed by Virginia Tech Transportation Institute and is owned and maintained by the Virginia Department of Transport. Transportation scientists and product developers spend thousands of hours conducting research on the highway.

The road is monitored from a control room that operates 24/7. Researchers can observe highway traffic and driver performance, directly and indirectly, through the use of surveillance cameras. Weather is generated from 75 towers that can rotate 360-degrees and tilt up and down. Researchers can make it rain—from a drizzle to a raging downpour. The towers can also create snow and ice, to facilitate research on the best systems for de-icing and anti-icing.

And there's more. The Smart Road can reproduce 95 per cent of all lighting conditions that a driver could encounter on US roads. A series of 400 electronic sensors embedded in the road provide a testbed for a variety of road conditions and elements, including testing new pavement options.

The road has an advanced communications system, including a wireless LAN interface with a fibre-optic backbone. The network can interact with several onsite data acquisition systems and road feature controls; the relevant information can then be transferred between a vehicle, the research building and infrastructure within the road. — Lynn Elsey

T

ink of roadways, and images of asphalt or concrete pavement take centre stage. It's easy to overlook the many components that make roads function: signs, traffic signals, lighting, drainage structures and guardrails. But these highway assets are the focus of transport departments as they help protect the safety of the motoring public.

Obviously, maintaining road systems across vast geographic areas is a daunting task. The Virginia Department of Transportation (VDOT) — working in partnership with a local university, Virginia Tech — is trying to make the process a bit easier.

A team in the university's civil and environmental engineering department, headed by Jesus M de la Garza, is laying the groundwork for powerful new technology to help monitor roadway assets.

The project aims to provide a better method of collecting information about the various roadway components. They are focusing on creating a system to allow data to be collected by a vehicle as it driven along a road. The information can then be evaluated back at the office — a far more efficient and safe method than the current practice of having crews walk along highways to evaluate conditions.

The research is taking place through the department's Center for Highway Asset Management Programs. The team is using a couple of innovative external tools, a Smart Road and a new IP-S2 mobile mapping system, as part of the project.

The Project

The Virginia Smart Road is a full scale, closed test-bed research facility, managed by the Virginia Tech Transportation Institute. It features a two lane, 2.2 mile (3.5-kilometre) road with state-of-the-art infrastructure that allows faculty and students to safely test vehicles and other traffic-related research in a realistic environment.

'Maintaining roads across vast geographic areas is a daunting task'

From the control centre, researchers can observe highway traffic and driver performance both directly and indirectly using surveillance cameras. Studies include testing new pavement markings, road signs, pedestrian safety and vehicle headlamps. "The Smart Road is really a 2.2 mile laboratory," de la Garza observed.

The team is testing the use of mobile mapping technology to monitor the road, using Topcon's IP-S2. Previously, faculty and surveyors have had to drive to the various regions and collect the data, often on foot.

The mobile mapping technology significantly reduces the manpower component of assessment. Because the van containing the unit can travel at 65 miles per hour, it allows a much higher capacity of data collection than someone on foot.

"We can then come back to the office and have technicians who can watch film, look for assets and assess the condition of the assets," de la Garza said.

He views the system development as a two-phase process. "The first step is having people watching film, which we need to do in the initial stages — that's phase one," he said. "Phase two is having computer programs that can actually find the assets by themselves."

Once the road assets are located, the software can also document their condition with the machine vision technology. "We need to create machine vision algorithms to find a sign, for example, and once found, determine if the sign is in good condition or not."

The system not only displays this data, it can also notify VDOT personnel when the asset meets or falls short of predetermined working condition parameters. A sign might have a certain portion of its surface covered with mud, and may or may not be considered in working order, for example.

The new system could provide "a huge cost savings for VDOT because 70 - 80 per cent of the cost of these maintenance programs is collecting the data," said Berk-Usho, one of the VTI team members.

"It is pretty labour intensive and there are some human mistakes, of course, when you're collecting the data."

The team received the van-installed IP-S2 unit late in 2009. It includes connections between the unit, vehicle and laptop computer, which allow data collection while driving. While the van moves along the Smart Road, or any highway, data is collected in a 360-degree radius around the vehicle. The system sets the distance from the vehicle where data is collected. The range is normally set at 10 metres, although it can be as much as 30 metres.
Applying the data
The team say that the real fun begins when they integrate the data from the different system components during a geo-clean processing. This process involves raw data being integrated with inertial post-processing to create a geospatial vehicle trajectory. Then Lidar point cloud is generated. Compressed image files from the camera are then converted and the digital imagery sets are registered to the trajectory and point cloud.

The team uses software called Spatial Factory to view, analyse, and extract features from the processed data. This merges the imagery and point cloud data "layers." It is possible to access GPS coordinates so that clicking on a Lidar point on the model reveals x, y and z coordinates.

The point cloud data layer allows the students to incorporate features such as topography and reflectivity of pavement markings into the GIS model. This additional information is revealed on top of the underlying image.

"If you have an excavation, a cut and fill project, you can get the dimensions of the current geography and upload it to any computer-aided design software. Then you can process point cloud data and compare it to the design that you have and then you can get the cut and fill exact," Uslu said.

Halfway through the year, the team had already laid the groundwork for phase one and is looking forward to the day when phase two becomes a reality.

The final result will, hopefully, lead to safer roads. ■

Don Talend is a US-based print and e-content developer specialising in technology and innovation.

Sourced from Australia’s Governments, PSMA Data is the underlying data incorporated in a broad range of fundamental services utilised by government, private sector and individuals.