

Enhancing train performance with Artificial Intelligence

4Tel CEO, Joanne Wust, tells *Rail Express* about how the company is employing AI to develop its advanced driver advisory system, to help train drivers be safer and more efficient.

ENSURING SAFETY WITHIN THE rail corridor is essential to the effective delivery of train services. Various hazards, such as animals and people wandering into the rail corridor, or vehicles standing stationary across level crossings, can cause serious injury and death and lead to serious service disruptions on a network.

Safe and efficient operations require a train's primary and secondary drivers to be aware of the precise location of the locomotive and the presence of potentially hazardous situations and objects along the route. In a high-consequence environment, train operators must keep an eye out for potential safety risks at all times, all while watching for safety-critical signals, and operating the train in as efficient a manner as possible.

This is no easy feat, and while train drivers in Australia and New Zealand are trained to a high level of competency, they are not infallible to human error. Fatigue, distraction and loss of concentration can affect anyone during a long journey. Complacency is a human trait that can set in for drivers operating the same route on a repeated basis, and a newer driver may not be as familiar with the route and its complexities.

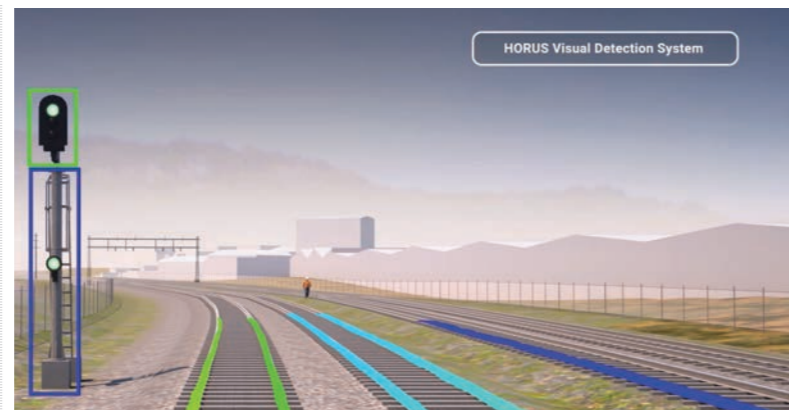
Newcastle-based digital rail specialist 4Tel is working towards a solution which helps drivers perform their jobs in a safer and more efficient way.

In late September this year, 4Tel carried out a test run of its latest solution, HORUS. HORUS is an Artificial Intelligence (AI) Machine Learning system for an Advanced Driver Advisory System (ADAS) – ultimately a machine-human interface that assists train drivers in the safe operation of locomotives.

The company has been working on the AI system since 2016. With progress speeding up, the project is now moving into the final stages of development of an initial version for operational use.

"HORUS is the next technological enhancement for improving train operations," 4Tel CEO Joanne Wust tells *Rail Express*.

"With this system, computers are able to sense a train's surroundings and detect abnormal objects within the corridor and even beyond the corridor. Digital technology can do things that humans cannot do. For instance, we can use cameras that have superb visibility at night or in fog – humans often struggle to see much in these conditions. Also, different kinds of advanced sensors can be used to feed information into the train's computers. Just as we humans use our different senses to detect whether or not we are in danger, sensor technology enables the same thing for AI computers,



but more effectively."

The HORUS system integrates the sensor data gathered from cameras, sensors and GPS in real-time. Using neural network processing in an on-board computer, the system carries out an ongoing and continuous comparison with previous data records of a given section of track. Advanced algorithms within the software then carry out processes for detection, localisation, awareness, dynamics and route monitoring.

"HORUS can classify what colours the signal lights are, compare that to the set aspect using data feeds from the control system to know where the train is supposed to be, utilise GPS for locational assurance (currently set to 50cm accuracy), and identify temporary or permanent speed boards to make sure that the train going at the right speed," Wust explains. "The system can also carry out calculations of the braking profile of the train. That means if a red aspect signal is coming up, the driver can be alerted and be assisted with the braking curve calculation."

HORUS features a central data centre that collects as-run video that is used to update the system's track reference record, or the route "master sequence". This process involves machine learning techniques, which assesses changes to the route on the basis of data collection, assimilating alterations and updating the master sequence. HORUS can therefore use AI to detect both normal and abnormal train operations at a given location.

"A route master sequence is the sum knowledge of what the AI system has learnt based on all the trains that have operated on that route. The more trains that operate a route, the more things are seen and processed, the more weather conditions are experienced, and the more intelligent the AI system will become in assessing

4Tel's HORUS Visual Detection System in action.

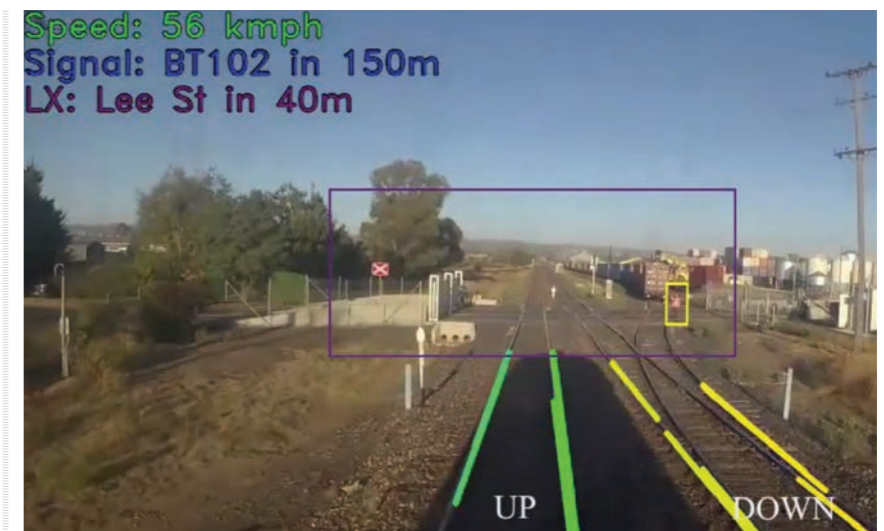
hazards from normal route operations, it has been, the more things it has seen, the more situations it has been in, the more intelligent the AI will become," Wust explains.

The process of developing the algorithms enabling the machine learning techniques took 4Tel three years with the research assistance of the University of Newcastle Robotics Laboratory. The technology is now at a stage where the data gathered from a sensor array on a moving train can be integrated and analysed onboard to provide real-time information to a driver.

"It took us some time to develop the mathematics, and then the computer algorithms, and get them right. And that's because very little formal research of train operating needs has been done before," Wust says. "The AI has to be able to interpret the different datasets coming from GPS, sensors, and cameras and provide an integrated analysis of this information. It is not to be understated how complex it is to do something like this."

HORUS is designed to support a variety of sensors, which would be selected in consultation with the train operator to achieve their stated operational outcomes. HORUS collects as-run data that is subsequently processed by the data centre to update the system's track reference record, or the route 'master sequence'. This process involves machine learning techniques, which assess changes to the route on the basis of data collection, assimilating alterations and updating the master sequence. HORUS can therefore use AI to detect both normal and abnormal train operations at a given location. The updated master sequence is then shared with all other HORUS equipped locomotives to enable continuous learning of all HORUS equipped locomotives.

Following the recent successful test run on



a training route through the Hunter Valley, 4Tel is planning to carry out additional train tests in the coming months. "We're really happy with the data output that has been achieved. It is now just a case of ensuring the algorithms are not presenting false positives, and that we are processing the information in an efficient way," Wust says.

According to Wust, the companies that decide to be early adopters of AI technology will see the most rewards: they will get to shape the outcome of their system. Once implemented, competitors will be behind the curve as they start to create a system that works within their environments. Not only will they be more competitive against competitors in the rail industry, but they will also become more competitive against competing industries, such as trucking.

"In the freight industry in Australia, trucks and trains are competing in the same space for long distance intermodal transport. Trucks are continuing to increase their capacity and efficiency with B-Triple

combinations now appearing on main interstate roads. Yet, currently, a truck driver can drive anywhere around Australia with their cargo. With a train, you've got two drivers and they are limited to the territory of their route qualification," Wust says. "We see this as an opportunity to assist drivers with better informed technology, to allow the drivers to handle all the tasks a computer can't do."

Currently, a train travelling from Sydney to Perth, for example, will have to pass through many different networks to complete the journey. However, train drivers may only be certified for certain parts of that network, which sets limitations on how each driver may be deployed.

"Our AI technology is not constrained by driver route qualifications or shift limits – it can operate along the entire length of the rail network and contain the route master sequence data in one system, which itself is improved by continuously learning from each train trip," Wust explains.

"Australia has some unique challenges – we have vast distances and the overall complexity of operating trains is quite high. So we have many reasons to adopt innovative technology to improve the safety and efficiency of rail transport," she says.

"We're excited about the technology we've been developing. It offers a lot of potential to the industry."

Contact: 4Tel.com.au

TOP: HORUS uses machine learning to enhance safety in the rail corridor.

LEFT: 4Tel recently conducted a successful test run of the HORUS technology.

