

NOWHERE TO RUN

HOW MACHINE VISION TECHNOLOGIES ARE WATCHING OUR EVERY MOVE

Our roads are getting busier by the day, so how can developments in machine vision technologies improve safety, help to reduce congestion, and prevent violations from taking place?

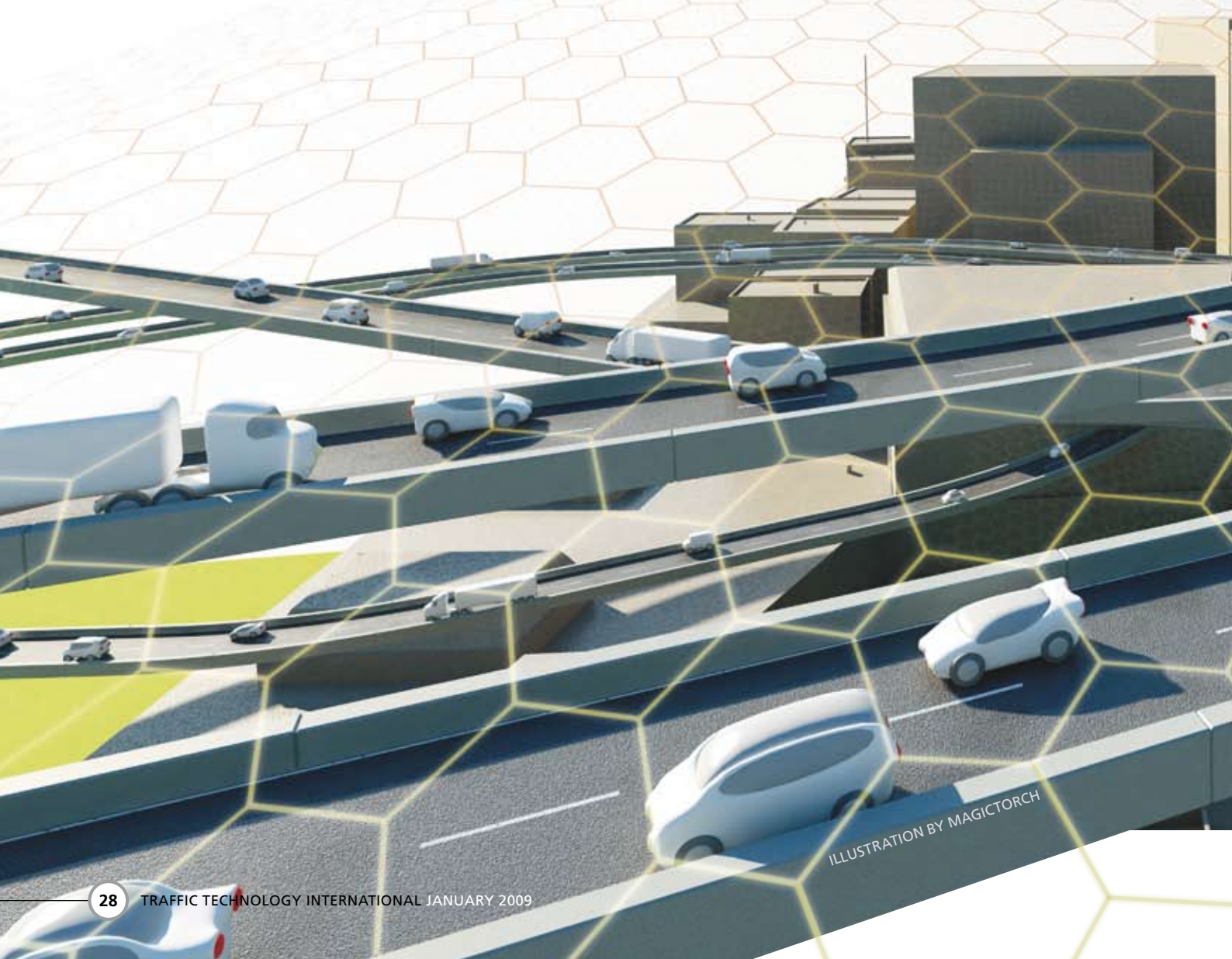
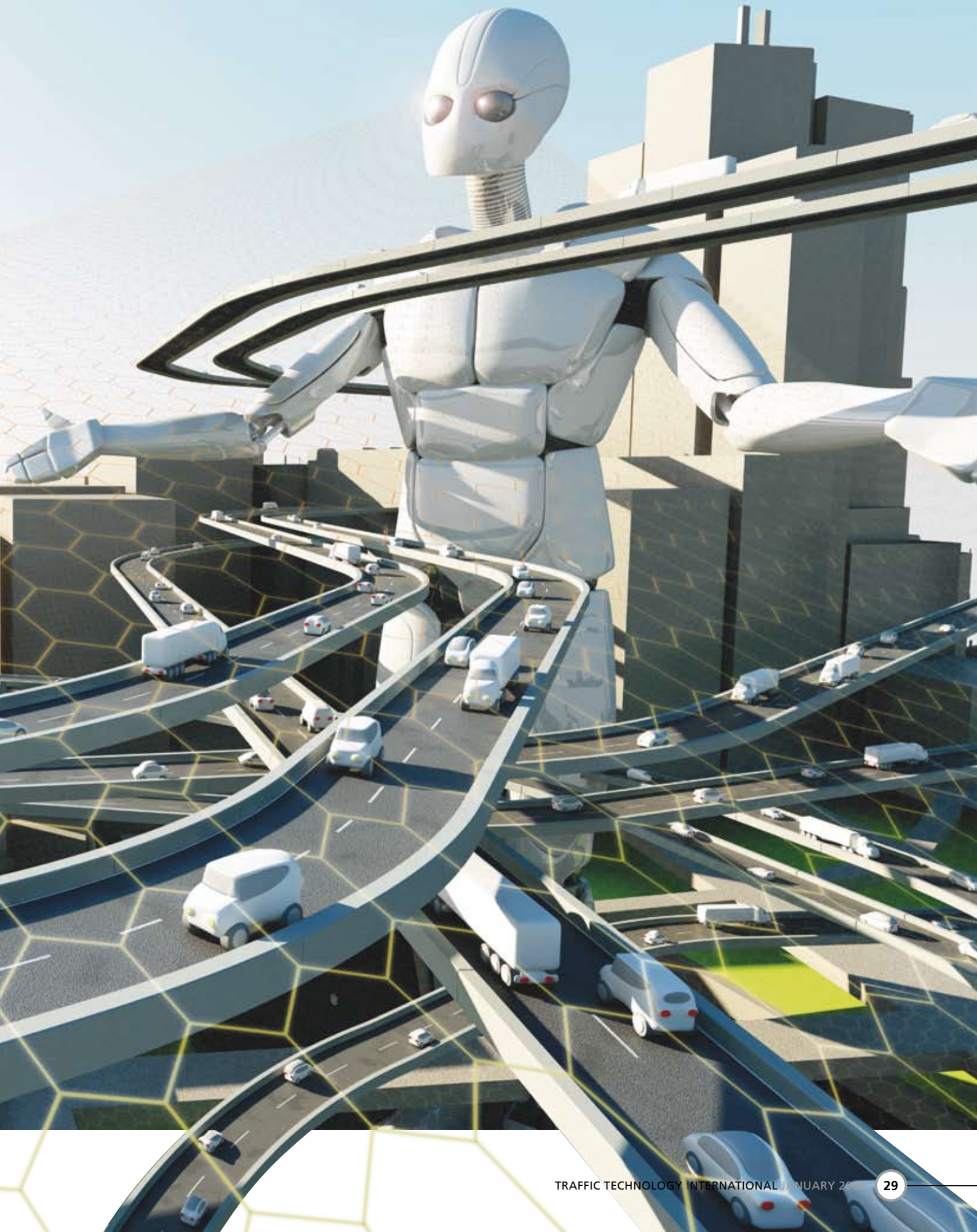


ILLUSTRATION BY MAGICTORCH



Replicating human vision with computers is a science born at the dawn of computing and has had a great impact in manufacturing automation. With advances in technology, the demand for what is known today as 'machine vision' has extended to other non-manufacturing applications, among them ITS, which requires much higher performance.

"Whereas manufacturing applications usually work in controlled environments, these new applications must work in outdoor environments under the most extreme lighting and weather conditions, and analyze unconstrained scenes, such as vehicles of arbitrary sizes and shapes moving at arbitrary speeds," explains Dr Ferran Lisa-Mingo, managing director of the Spanish company Imagsa Technologies. Machine vision systems have big potential in the ITS sector, helping authorities to enhance efficient and safe use of roadways while also simplifying the collection of tolls. But what are these technologies and how can we be sure that they are providing us with reliable information?

Machine vision mimics human vision and is the ability of a computer to see – a term used to describe the capacity of a machine to analyze its environment from images. By using high-tech cameras and/or scanners, images can be collected and then sent to be processed by a computer, which is similar to human vision where the eyes capture images and the brain processes them to allow us to see. In the traffic market, in particular, machine vision systems can be used for speed enforcement, ALPR, analyzing road surfaces and detecting obstacles in the road.

MAKING THE RIGHT CHOICE

Such advanced technologies are becoming increasingly important in today's traffic market. Factors such as congestion, speeding, stolen vehicles and safety can all be controlled through the right machine

vision system. According to the Automated Imaging Association (AIA), the market value for this wave of technology in the US ITS sector alone exceeds US\$140 million. The goal now is to optimize transportation efficiency further through the use of the best technology. With the right camera, machine vision systems can increase productivity, simplify maintenance and lower total cost of ownership, which is especially important in the traffic market where there are limited budgets, there are lives at stake, and congestion costs economies billions.

Sony Image Sensing Solutions (Sony ISS) is a developer of machine vision and visual communication products, and primarily works with OEMs, integrators and major manufacturers, which in turn implement its camera modules into a vast array of systems, including traffic monitoring. Arnaud Destruels from Sony ISS highlights the main benefits of these intelligent imaging systems: "Before their introduction, the traditional method was to have a remote camera linked to a PC by cables. Today, machine vision technology offers an 'all-in-one' solution. For example, the Sony smart camera is a PC with a high-quality integrated camera. Image processing is conducted by the camera before the data is transmitted, bringing benefits including cost savings, flexibility, reduced time and maintainability."



Arnaud Destruels, European marketing manager, Sony Image Sensing Systems, France

"Vision technology in the future will be able to give more reliable information, such as color – for vehicles, there's a huge difference between a black and a blue Mondeo"

ENFORCEMENT AT THE RED LIGHT

→ Vitronic's development department in Wiesbaden, Germany, has been working hard in 2008 to develop several new products to supplement its existing range of traffic technology solutions. Among these new releases will be the PoliScan Red-Light, which is set for launch in the second quarter of 2009. The product enables enforcement at junctions and is based upon a laser detection and tracking system. As one of the first of its kind in the world, this requires no in-road equipment, such as piezo sensors or loops, lightening the installation and maintenance costs and workload as a result.

As a vehicle approaches a red light, the system senses whether it is about to stop. If it fails to do so, an initial image of the

vehicle is taken as it crosses a virtual stop line. If the vehicle continues into the junction box, a second photo is captured which provides evidence of the violation. As with the PoliScan Speed, this is capable of enforcing multilane roads, irrelevant of the speed or position of the vehicle.



Up to two measuring and documentation units in a single pillar check speeds in both driving directions





Vitronic's TollChecker is a major part of the German truck-tolling scheme, enforcing the correct payment of tolls

DISTRIBUTING INTELLIGENCE

→ Dr Ferran Lisa-Mingo from Imagsa Technologies looks closely at how he believes the ITS market could be improved in the future. "As traffic problems increase much faster than the budgets of governments for ITS, the only possible direction for the community is to invest in more intelligent systems – and machine vision is among the most promising tools for that purpose. Traffic problems are growing steadily everywhere, therefore it is clear the best choice for future ITS will be distributing intelligence. This means that current architectures with standard video cameras connected to a central control room should be replaced in the future

Imagsa Technologies' Atalaya series of smart cameras



by smart cameras capable of extracting relevant information locally and sending it to those decision points at the right moment.

"Some basic understanding of the technologies and techniques in machine vision would allow the different participants in the market to make the right investment decisions and get the best results from installed technologies."

The continuous development of cameras is essential to ensure traffic monitoring needs are being met. However, the traffic and ITS markets still have a long way to go in terms of utilizing more advanced image visioning techniques. "We believe vision technology in the future will be able to give much more reliable information, such as color – if you're trying to find a vehicle, there's a huge difference between a black and a blue Ford Mondeo."

This kind of development is already under way at Sony ISS, as the company has recently launched the XCI series. This is a set of next-generation smart cameras, which have improved flexibility, performance and the ability to undertake color analysis. This means, for example, that license plates can be checked against a car's registered color, helping to identify theft more easily and give more information when detected.

THE MACHINE VISION TRADE-OFF

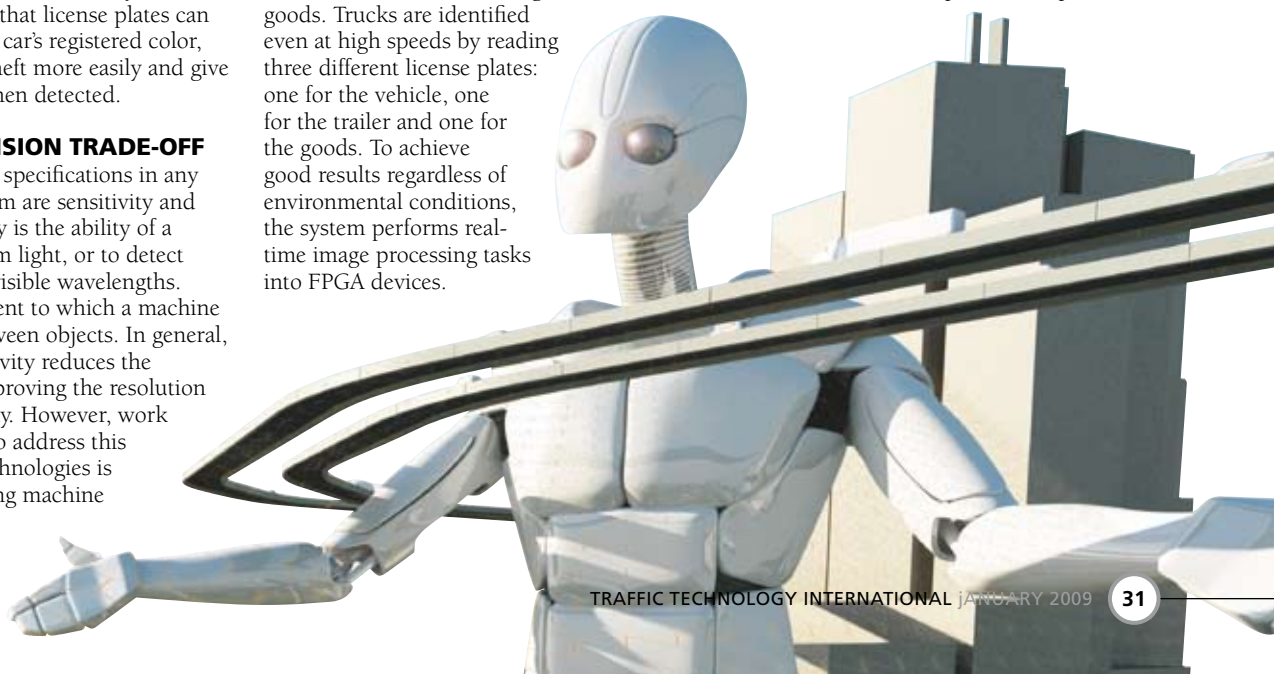
Two other important specifications in any machine vision system are sensitivity and resolution. Sensitivity is the ability of a machine to see in dim light, or to detect weak impulses at invisible wavelengths. Resolution is the extent to which a machine can differentiate between objects. In general, increasing the sensitivity reduces the resolution, while improving the resolution reduces the sensitivity. However, work is being conducted to address this problem. Imagsa Technologies is focused on developing machine

vision systems for outdoor applications. Its technical skills and experience include the development of image processing solutions based on FPGA devices capable of analyzing scenes under challenging environmental conditions.

"Our products use high-performance capabilities to address the challenges of outdoor machine vision," says Lisa-Mingo. Its first product for the ITS sector was an all-in-one programmable platform called Atalaya, which includes smart infrared illumination for 24-hour operation and high-speed image acquisition and analysis. This smart camera system has been used to make up the product DG Sentinel, intended to control vehicles with dangerous goods. Trucks are identified even at high speeds by reading three different license plates: one for the vehicle, one for the trailer and one for the goods. To achieve good results regardless of environmental conditions, the system performs real-time image processing tasks into FPGA devices.

CHALLENGING TIMES

Environmental conditions are another big challenge facing the machine vision component manufacturers in the traffic sector. Products need to withstand, among other things, heat, freezing temperatures, wind and rain. Therefore, not only do they have to be highly technical, but they also have to be strong and robust. Vitronic develops, manufactures and supplies standard and turnkey solutions for the ITS sector. Products within its Traffic Technology division include systems for vehicle detection, identification, classification, tracking and enforcement, divided into two product families, PoliScan and TollChecker. One product, a speed

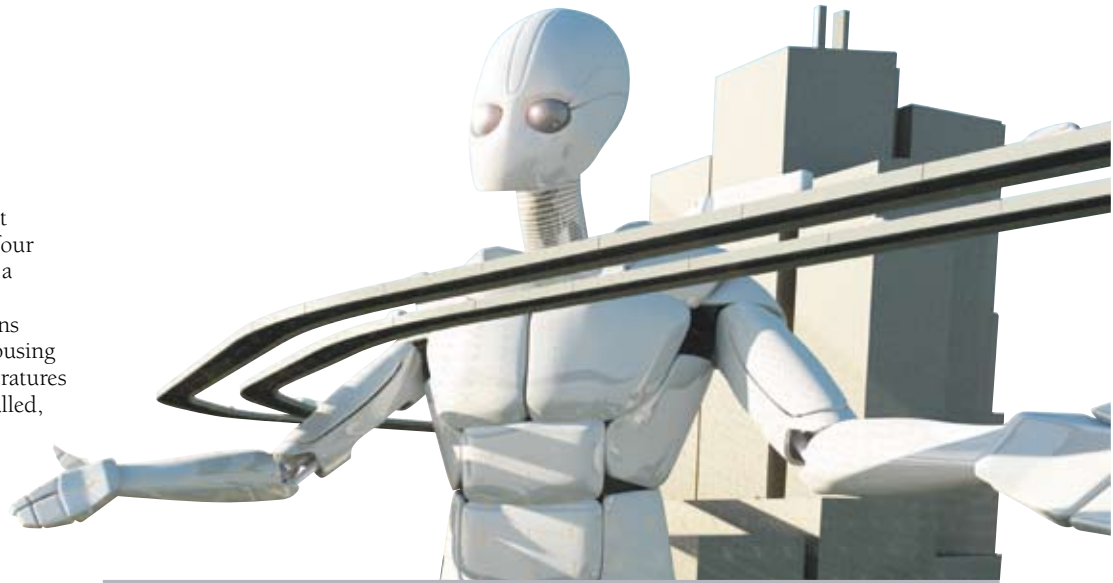


detection system which uses a next-generation detection and tracking unit (DTU) to capture offenders on up to four lanes, has recently been developed in a specially designed dual-use housing.

Vitronic's Adrian Wilkinson explains how the solution works: "The dual housing allows the system to operate in temperatures between -30°C and 50°C. When installed, the mobile system is mounted onto an internal metal wall. To provide complete protection from external interference, the inner housing is surrounded by a second casing constructed from steel plates. Clear security glass also offers a safeguard from vandalism. Furthermore, the outer steel housing serves as a sunroof to prevent the inner housing from direct sunshine, and to help provide maximum capture rates."

With the amount of vehicles on the road increasing at a steady rate, it is essential that the next-generation machine vision technologies can not only withstand extreme weather conditions but can also capture more. But with a wider field of vision, resolution is usually compromised. However, similar to the other challenges present in the ITS machine vision market, technological progress is helping to ensure cameras are capturing large, clear and defined images. A prime example is Stemmer Imaging's object-recognition software.

The company's cameras offer high resolution, high sensitivity and fine precision for advanced traffic management applications, including speed enforcement, tolling and incident detection. Looking closely at the organization's object-recognition software, Patrick Gailer, product manager for vision hardware, comments: "It can detect the presence of vehicles as well as the types of vehicles, such as small cars, large cars, vans, taxis, buses and trucks. It



COLOR ANALYSIS ADDS POTENTIAL

→ Sony has recently added performance, flexibility and color to its next-generation smart camera lineup through the XCI series. Launched at the Vision Show 2008 by Sony Europe's Image Sensing Solutions (ISS) division, the four new camera modules process image data before transmittal to a PC, and combine a powerful CPU with an open field-programmable gate array (FPGA). This latest launch delivers a threefold performance improvement over the previous generation.

The camera's FPGA provides preprocessing for real-time raw image data without any load placed on its 1GHz CPU, reducing the camera's power consumption. To add flexibility, the function of the module's four inputs and eight outputs can be specified using the FPGA. The open platform enables a user to specify and design niche functions, and the addition of color analysis in two of the four new camera modules enables them to be used in a range of markets, including machine vision applications.



Meinrad Simnacher, managing director
Leutron Vision, Germany

"The aim is to reach a high degree of interoperability between manufacturers, particularly between the cameras and software libraries"



Leutron Vision is developing products geared towards interoperability between machine vision manufacturers

can also be programmed to detect any new types of vehicle that may be designed in the future. Over the next few years, we hope that this technology will advance further and be able to detect different makes and models of vehicles. We have already undertaken several positive feasibility studies to prove that this is possible."

INTEGRATED SYSTEMS

These are just some examples of the challenges in the traffic machine vision sector and how they are being overcome. ITS has seen many developments over the past decade. Companies are now moving on from basic standalone systems to more integrated solutions, combining the functionalities of previously separate machines into one convenient package, thereby resulting in lower installation and maintenance costs. Continuous development in this area will take advances in technology even further. So, what does the future hold for machine vision? After consulting a number of companies in the industry, it is clear that the

future challenges of outdoor machine vision in cost-sensitive markets such as ITS can only be addressed with highly technical and compact solutions. The close cooperation of the different manufacturers is also essential to ensure needs are being met and challenges are overcome.

Concluding, Meinrad Simnacher, managing director of Leutron Vision, highlights one development that may affect the machine vision sector over the next few years. "GigE Vision is a new camera interface standard developed using the Gigabit Ethernet communication protocol. The aim of the standard is to reach a high degree of interoperability between individual manufacturers, particularly between the cameras and the software libraries. For the first time, machine vision cameras can connect automatically to all major image-processing libraries without dedicated plug-ins or drivers. This standard is ideally suited for the traffic markets and in the future we hope it will reduce costs and development times." ■