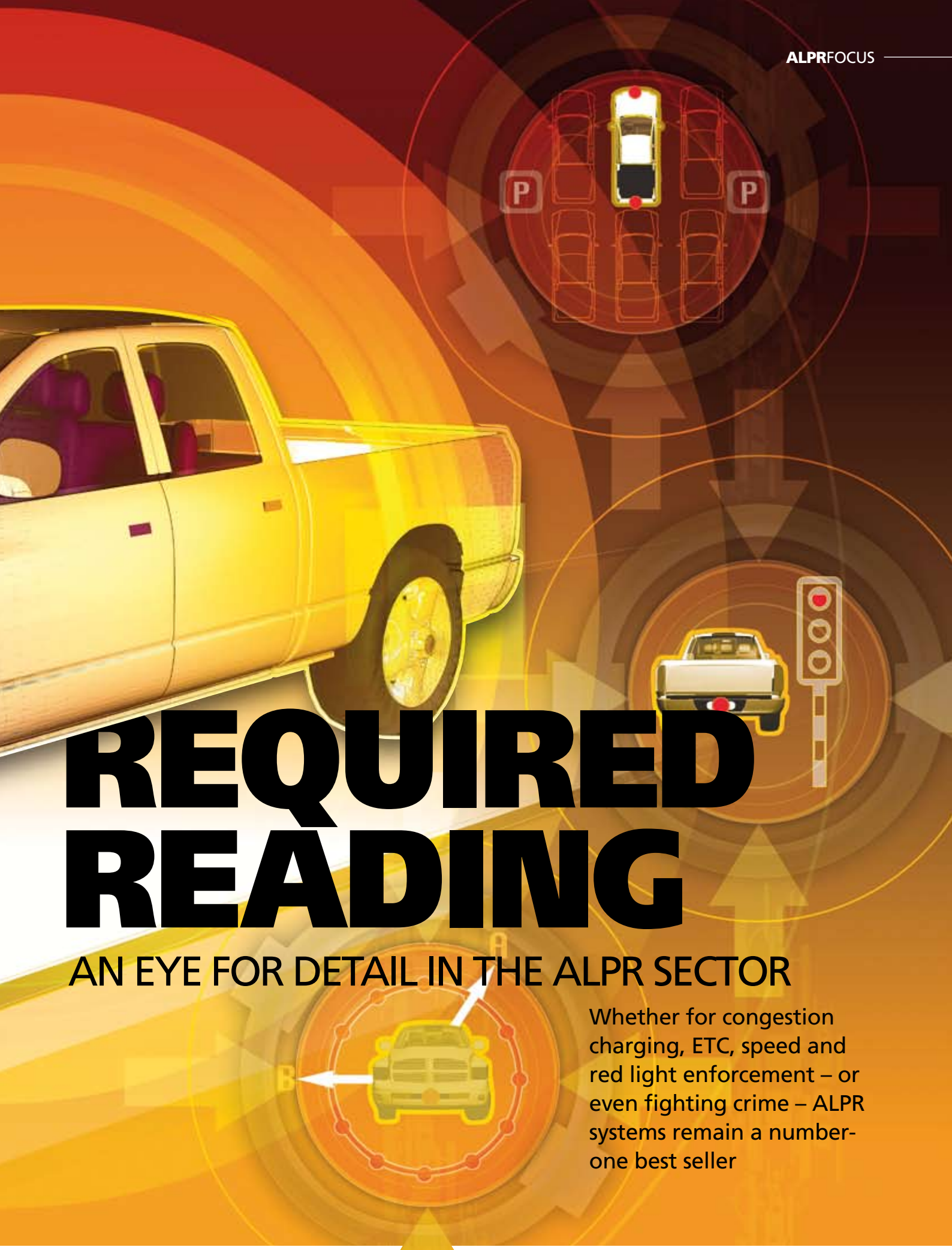
by Louise Smyth

Illustration by Flatliner



REQUIRED READING

AN EYE FOR DETAIL IN THE ALPR SECTOR

Whether for congestion charging, ETC, speed and red light enforcement – or even fighting crime – ALPR systems remain a number-one best seller

Continual references in the mainstream press to 'Big Brother' and how society is veering toward some kind of 'Orwellian dystopia' are frustrating. A recent talking point to be adorned with such comparisons, in the UK at least, was the possibility of a national DNA database. It's lazy journalism and guilty parties should be sent to Room 101.

The comparison is not even particularly apt – a *Catch-22* analogy seems more appropriate. With reference to our roads, a Joseph Heller-style conundrum works well. We want free-flowing traffic, criminals removed from the road, cheaper car insurance, and the threat of terrorism dissolved – yet we appear equally desirous of personal freedom, liberty and the 'right' to live our lives free from omnipresent surveillance. Education and logic are key: do the advantages of potential systems outweigh the disadvantages? In the field of ALPR, it's a no-brainer.

As much as the moral issues surrounding ALPR are interesting, the business side is also intriguing. Some companies in the field offer complete systems from software engine to camera, while others buy in components and tailor products to their own individual needs (badge engineering).

The UK benefits from an extensive ALPR camera network, used for traffic management, enforcement, ETC and congestion charging

LOCAL AUTHORITY

The UK has traditionally been the home of ALPR (or ANPR): it's where it began, and the country continues to be a leading light. One Englishman well-versed in this technology is Lawson Noble, CTO of CitySync. He is watching his company end 2007 with a turnover that's almost doubled – the highest growth year so far. Persistence is key to his approach: "We first made a bid for the Western Extension of the London Congestion Charge scheme two or three years ago. We didn't succeed but still carried on the momentum and development, progressing the Blackbird PC, a highly rugged roadside PC. We've sold around 400 now and haven't had a single one returned."

Governmental work that CitySync has been involved with has demanded extremely high accuracy on multinational plates, and some lateral thinking helped meet this requirement: "Some of our projects recently have been using white light (which is quite a shock having spent 10 years with infrared), because you have to read non-reflective plates as accurately as reflective plates."

CitySync's latest product is the JetCam Fox HD camera. "True infrared high definition is one big advantage we have over everybody else. We can read two lanes, a 7m field of view, using only one pole, instead of a gantry. High definition uses gigabit ethernet technology. You have the ability to control the camera frame by frame between grabs. So if it is dark, wintry weather, you can push it to its limits. What ALPR is very good at – and a lot of people get this wrong – is reading almost black plates. Bright plates thin the characters so you get misreads, whereas dark plates look black to the human eye but a camera can distinguish very well between black and almost black."

As well as offering a web-based back-office system (JetOnline), WIM traffic systems, a newly written journey-time monitoring system, and a frequent visitor system (for waste management plants or secure sites, such as national embassies), expansion plans are accelerating for CitySync. The company opened a US office earlier this year and has been conducting "high security" work in Washington, DC. Breaking into the US market was prolonged until Noble and his colleagues could guarantee it could be truly competitive: "We've gone in later than everyone else deliberately, but we've gone in with what we think is better technology. We didn't want to do what happened in the UK: the UK ALPR was launched too soon and it gave it a bad name, which took years to mend. Going in with HD cameras makes sense. They enable us to cope with thinner stroke width and still achieve the greater accuracy."

"We've gone in [to the USA] later than everyone else deliberately, but we've gone in with what we think is better technology"
Lawson Noble, CitySync, UK

Accuracy is a big motivator for Noble. Neural network systems he critiques as being less reliable: "They learn – and anything that learns can unlearn. For instance, dirty license plates: recognition can change slightly with the seasons, whereas the technology we use has four methods of ALPR already built into the engine."

The methods consist of basic checking to look for obvious characters, next is template matching and then contour mapping. "We use two types because a template is very good if, for example, you've got a different-colored bolt in the middle of a 'Z' – there will be a hole in it, but if you match the template, it's still the nearest match. Contour maps are very good if you're not quite sure about something – you can trace the general

The Jet Blackbird ALPR remote processor unit

CitySync's JetCam Fox HD camera system

Futronics' unlicensed-vehicle detector, Stingray

shape around it. We use a fourth method of absolute discrimination. This means that if you really can't tell whether it's a '5' or an 'S', special algorithms look at thousands and thousands of '5s' and 'Ss' and then make a decision based on the results."

SEAL OF APPROVAL

Another supplier in the area is Futronics. It has the only Home Office-approved ALPR technology in the UK and Northern Ireland, a system that is used to assist the DVLA in going after the one million unlicensed vehicles on UK roads each month.

Fifteen vehicles equipped with the latest Stingray Unlicensed Vehicle Detector (UVD) mobile equipment are currently in operation. The Stingray system is capable of working day or night with vehicle speeds in

I'VE GOT YOUR NUMBER

Peter Vermaat is a senior ITS consultant with TRL in the UK, and has 15 years' experience in the design and deployment of ALPR

"ALPR systems generally use two types of camera," details Peter Vermaat, TRL, who until late-2006 worked with ALPR supplier Appian Technology. "Systems either employ standard CCTV or, more commonly, dedicated ALPR cameras that tend to use built-in infrared illumination. Virtually every country in the world uses retro-reflective plates, which means that if you shine a light at it, the light reflects straight back at you. Infrared ALPR cameras use infrared illumination usually based on diodes. The infrared light illuminates the license plate and it reflects back quite powerfully. So, by using a fairly small compact camera, you can read license plates 24 hours a day."

Computation is the first step. Several companies sell cameras with a built-in computer and Vermaat believes all manufacturers will eventually head this way. "The computer performs a standard set of localization techniques, where there's an algorithm that seeks plate-like objects in the image, usually by looking at contrast. What it's actually looking for are the edges of the characters, searching for black-to-white/white-to-black transitions. If they fit a certain pattern, the algorithm decides that there is a potential license plate there. The next step is to localize the edges of that plate and to straighten it all out, which is called de-rotation, or de-skewing."

Segmentation is the next stage, i.e. breaking up the image into individual characters. This has long been a challenge, as characters can often be broken up anyway, either intentionally or due to dirt or damage on the plate. Vermaat cites a classic example, whereby two '1s' next to each other are turned into a letter 'H' with a strategically placed bolt. All algorithms have techniques that enable further analysis in these cases.

Classification comes next. "Three different techniques are used here," Vermaat says, "including neural networks, rule-based systems and template matching."

Finally, a syntax (or context) check confirms that the plate fulfils the criteria to be deemed a legitimate license plate.

Vermaat believes that part of the success story of ALPR in the UK is historical – successive governments have embraced it

and allowed it to flourish. "UK companies are the world leaders. As a lot of the customers are governments, they are keen to buy from local companies."

Can this success continue unabated? "The technology is slowly becoming a commodity – it's still high technology, but prices are falling. People will eventually use it for things like access control into their own homes, so you'll drive up to the gate and a cheap system (eventually for just a few hundred dollars), will run a check on your license plate."

Vermaat sees no short-term threat from evolving technologies such as RFID tags replacing license plates: "Five years ago, we were being told that ALPR only had a five-year life expectancy, and after that everybody will have RF tags for their license plates. There isn't yet a single large country that's implemented it. Companies are offering RFID tags embedded into license plates, and it is likely that eventually every vehicle that comes off the production line will have one. But the advantage of ALPR is that it is reading the same thing that people can see – I don't think that will change."

Vermaat is reluctant to offer a personal view on the political issues that plague this topic. Instead he references something that goes a long way to dispelling some of the negative publicity surrounding the use of ALPR: "The following can be found on the Home Office website: 'ALPR has enabled police officers to produce an arrest rate equating to over nine times that of the nationally accepted average and to achieve three times the number of Offenses Brought to Justice compared to conventional policing methods.'"[1]

[1] *http://police.homeoffice.gov.uk/operational-policing/technology-equipment/automatic-plate-recognition/?version=2*

Arrest rates increase ninefold with ALPR

License plates are under no short-term threat

excess of 100mph. License plates can be read and checked against 23 million records in a second and, if matched, digital video images are captured and encrypted to two CD-ROMs simultaneously, with exact locations (via GPS), and time and date.

The company is presently working on camera system technology that calculates average vehicle speeds using ALPR and vehicle tracking. Anthony Parfitt, managing director, says: "We have seen a huge demand for our ALPR solution over the past eight years. I believe in 10 years' time, ALPR will be standard on all police vehicles and there will be permanent ALPR camera installations on all major UK motorways, as well as large housing estates and in city centers."

QRO Solutions also works closely with police authorities in the UK and abroad. The company buys in a software engine and creates portable ALPR systems built around a commercially available laptop. "Our products provide an integrated approach to security, allowing the output of numerous ALPR systems to be monitored in one location by a small team of staff," explains QRO's Vic Way. "Using mobile phone technology, the output of several ALPR systems can be linked to security control rooms, allowing vehicles entering a

specific area to be screened in real time, and providing information to officers should a breach occur."

As well as portable solutions, QRO systems are also installed permanently to provide surveillance of strategic points on the roads network.

THE ENFORCERS

A new product is also joining the market from Watchman Traffic, as detailed by Jim Barnard, managing director: "We make the D1 numberplate recognition camera ourselves. Attached to it is a radar unit that will pick up the speed of approaching vehicles. It has an intelligent board that we can set to output the speed of any vehicle going over whatever threshold we say. If any vehicle exceeds this, the radar provides an output that shows the speed in ASCII text format, which we then embed onto the video picture from the ALPR camera."

The system has been deployed successfully in the UK at bus depots in South Yorkshire after accidents involving buses and pedestrians created the need for bus drivers to stick to a 5mph limit.

Watchman buys in the radar unit from AGD and purchases the software engine from the Far East before modifying it to suit using an SDK (software development kit.)

The company is additionally a CitySync reseller, so for contracts such as a recent deal with the police authorities in Wales, a CitySync engine was employed as the police were familiar with its interface.

"Journey-time monitoring is one area that we are also becoming more involved in," continues Barnard. "The system uses our own Scout camera – an ALPR unit with embedded software and 3G transmissions. Two cameras are set up on the road, which feed data by GPRS or 3G to a control room to calculate journey times." Already in use in the UK, the system is also being trialed in Spain for a speed-over-distance project in a 3km tunnel. If successful, it could be used for enforcement of the tunnel's speed limit.

LEARN FROM EXPERIENCE

An ALPR system forms the heart of TfL's new project: the Low Emission Zone (LEZ) that goes live next February. Siemens is supplying and installing the system

The aim of this London-wide zone is to discourage the use of the most polluting lorries, coaches and buses. Operators that do not comply with the LEZ standards will have to pay a £200 daily charge to drive these vehicles within the zone.

Siemens Traffic Controls will deploy ALPR cameras to identify vehicles that are producing emissions in excess of the standards. The cameras are being bought in from PIPS, and Peter Preston from Siemens explains that the system is 'very similar to what we've done for the western extension of the Congestion Charge. But LEZ is a softer application – it is about saving the planet rather than charging the motorist.'

Siemens has gained much ALPR experience in the field of journey time monitoring, where it has had success using PIPS cameras and processing technology

Siemens is installing cameras at 75 sites

and its own software for collating and matching: "The system does a search for a match of a specific plate, so it can build up a database of journey times. Unlike enforcement applications, you don't need to get every plate."

Users can also gain from this 'pick and mix' approach. Siemens' journey time ALPR can be bought as a standalone system, but it is also part of the widely used COMET software. If ALPR is to remain in the future then this type of integration will be key.

"ALPR will be standard for all police vehicles, with permanent installations on all UK motorways, as well as housing estates and city centers"

Anthony Parfitt, Futronics, UK

Watchman Traffic's ALPR camera technology

An interesting application for enforcement is a system that Vitronic has installed for police authorities in Germany and Switzerland. Michael Leyendecker from Vitronic explains the intricacies of the 'Wanted Cars' system: "It scans all vehicles passing the virtual checkpoints and compares the license plates in real time against wanted-cars databases. If a wanted car is detected, an alarm is generated and sent to the police. Installations include tripod-mounted, gantry-mounted and semi-fixed ALPR systems."

Laser triggers are used so that vehicles can be captured while driving at high speeds, driving bumper to bumper, or changing lanes in the camera's field of view.

Designed for international, cross-border use, Leyendecker believes these systems will become dominant in the near future: "Automated searches of wanted cars will become standard practice in virtually all major countries in 10 years' time. But the intensified control has to be balanced with high levels of privacy protection. We believe that privacy and ALPR checks are not a contradiction, but can be reconciled through intelligent system architecture."

Vitronic's Wanted Cars system compares in real time all license plates against a wanted-cars database

PROTECTION POLICY

One US supplier that is big on protecting citizens – and conducts a great deal of work at national borders – is Perceptics. The Knoxville-based company's latest contract is with the Canada Border Services Agency,

The Perceptics system automatically captures, identifies and records the alphanumeric code, state/province of origin, and country of origin

working on the IPIL (Integrated Primary Inspection Line) program. The project has involved replacing existing Perceptics systems that Canada uses at its border. As a vehicle approaches the border port of entry, the system reads the license plate, identifies the state or province of origin, then compresses the image and instantly displays it for the border services officers. The new equipment boasts at least 95% accuracy on the read rate, including license plate number and state/province of origin identification.

Perceptics uses its own software engine, and John Dalton, president, is extremely proud of this evolution in identifying state or province of origin: "In national security it's vital. It operates with all different types of license plates and as far as we know, Perceptics is unique with this."

PERFECT COMPLEMENT

PIPS Technology, now part of the Federal Signal Corporation, has just launched a new camera tailored toward the ORT market. Brian Shockley from PIPS outlines the P382 Spike2: "It delivers full-lane coverage, with a 13ft field of view, which eliminates the need for multiple cameras to capture vehicles changing lanes or straddling the lane. The P382 Spike2 is of a dual-lens design, featuring high-definition monochrome with integrated color, so you get a full-color image of the vehicle for evidence and also a high-resolution monochrome image, from which the license plate read takes place."

PIPS's P382 Spike2 is ideal when multiple lane coverage is required from a single ALPR unit

PIPS is one of a select few companies that designs and engineers the complete ALPR solution, from camera and OCR engine to processor and hardware. The cameras use infrared illumination and a patented technology called Platefinder: "This looks for the presence of a license plate based on size and reflective properties of the plate," Shockley explains. "When it sees that plate, it triggers the camera internally to capture images, beginning by capturing multiple images – another patented technology called Triple Flash. With each image that it captures, the flash, shutter and gain settings on the camera are varied to get a different view of the plate, before the best-quality image is passed onto the OCR engine."

Like Perceptics, PIPS is working on ways of identifying the state of origin of the plate and there is a patent pending on a specific new technology, which we can expect to hear more about from the US side of operations very soon.

A less-known company is Adaptive Recognition from Hungary, which also makes its own engine. Tamas Lazar tells us

THE PLATE PRETENDER

Cars without license plates have been predicted for years, but are yet to materialize, despite the considerable advances in EVI in recent times

Although those involved in ALPR see a healthy future, the electronic number plate, or EVI (electronic vehicle identification), could eventually upset the apple cart.

In 2006, the DVLA in the UK produced a feasibility report, *Electronic Number Plates [ENP]*, and committed to trials investigating the technology. Conducted with four regional UK police forces, the aims were to determine whether microchips placed in license plates could provide a reliable and practical method of identifying vehicles by verifying system performance, particularly in regard to read accuracy. The trials would also establish whether EVI could add value to the identification of vehicles via ALPR equipment, as well as help the police assess EVI's potential for combating vehicle-related crime.

On the face of it, the case for EVI appears to be sound. As license plates are relatively easy to make, it is believed that fitting an electronic registration tag to them would make unauthorized manufacture more difficult. Stolen vehicles and cars used for criminal activity are commonly fitted with false plates – and these cars are statistically more likely to be involved in road traffic accidents. There is also evidence that some motorists are displaying the wrong plates to evade fines and charges, and instances have already been reported in relation to congestion charging schemes. And if license plates are interfered with, it can be difficult for both the human eye and ALPR systems to register an accurate reading.

Generally, the police regard EVI as complementary to ALPR – a view shared

EVR uses RFID to identify vehicles and validate the identity, status, and authenticity of data

that the founders of his company were all mathematicians. "They began to develop the OCR engine in 1991. Since then, we have been continuously developing the technology, based on a neural network, and the SDK. Recognition is based on a learning process rather than geometrical analysis."

Lazar believes using a neural network brings flexibility to Adaptive Recognition's products: "It can easily learn for new regions. To adapt for a new country, we only need a few thousand pictures of license plates and in a month we are able to issue a new engine that can achieve 98-99% accuracy." Adaptive Recognition's systems are also able to read license plates from every continent, encompassing Latin, Chinese, Arabic and Cyrillic characters.

Lazar predicts a big future globally for ALPR: "I think the market will grow substantially in the next 10 years, with parking and security applications being installed at a vast rate."

Most ALPR systems are capable of accurate high-speed license plate recognition from multiple lanes of high-speed and high-density traffic

AND STILL TO COME...

Appian Technology's latest news supports the notion that there is plenty of life left in the market. The company has recently won five contracts from US police departments for its Talon mobile ALPR system, while several new products have been unveiled, including the Cobra infrared zoom ALPR camera. In eight months, 950 of these units have been sold.

Also being well received is the Viper – a high-performance color camera for mobile ALPR, of which 70 have been sold. Another recent launch is the Stinger, an intelligent camera with onboard image processing.

The company has been involved with a congestion charging scheme in Malta, which has now gone live. Together with its partner, CVA Technology, Appian has installed the complete system and because it is a privately funded initiative, both companies now draw revenue from the scheme. Tom Keene, commercial director, outlines the details: "Like most European cities, the City of Valetta in Malta has severe traffic congestion, compounded by the medieval urban space and a dramatic recent rise in vehicle ownership. In an effort to reduce the problem, a highly effective ALPR-based congestion charging system has been implemented – an integrated, ready-to-use turnkey package. The system is comprised of four key elements, including ALPR cameras, software, back-office database software, and automatic payment and billing software."

The Talon system's recognition is based on a neural network that Keene says uses a unique mathematical perceptron model. "Unlike multi-layer perceptron models (MLP), the Talon model cannot suffer from 'over-learning' and a reduction in accuracy." Multiple-recognition results are obtained for each plate that is read and an advanced post processor analyzes the results to achieve the most accurate reading.

To progress even further in this field, as well as developing a new hybrid engine that merges the best features from the existing Talon and Shark engines, there are also plans to bring to market a full-digital ALPR technology offering. ■

Police authorities generally regard EVI as complementary to existing technologies

by 3M's Terry Griffiths, who works on a product called 3M EVR (electronic vehicle registration). "But we would submit that the costs associated with deploying an ALPR-only system that had the capability to achieve the capture rates of a 3M EVR system would be considerably more expensive than either a 3M EVR-only system, or even a hybrid 3M EVR/ALPR system."

This, he explains, is due to the number of cameras needed to address occlusion issues surrounding camera technologies, and also due to the human resources required to intervene if the camera cannot effectively determine a license plate's alphanumerics. "Our system allows agencies to accomplish multiple objectives from one technology platform, with a successful capture rate of well over 99%," Griffiths continues. "Line-of-sight issues do not generally cause problems for the 3M EVR system, and it greatly reduces the need for human interaction to monitor its effectiveness."

3M has deliberately integrated OCR technology into the system as an option for when violation processing is part of a program. "As the vehicle population continues to rise and subsequent demands on the infrastructure increase, agencies need to find an automated way to manage the balance between safety and efficiency and budgetary constraints." For example, the 3M EVR system can also be deployed to address congestion pricing programs, to pass along the costs of infrastructure demand to those who are using it during peak times.

"Deploying the system in a city or region offers a DOT a robust technology that can be scaled to meet immediate demands without limiting long-term strategy," Griffiths suggests. "If an agency simply wants to understand traffic patterns so that it can develop programs to encourage transit use, the 3M EVR system can help."

Bermuda recently implemented an island-wide 3M system. With the world's highest density of motor traffic, all of Bermuda's vehicles are now fitted with tamper-resistant RFID window sticker tags, initially through the vehicle inspection and registration process. The system verifies vehicle registration compliance via a network of fixed reader points, transportable tripod-mounted readers and handheld readers for screening vehicles at random locations.

The system comprises RFID tags, antennae, readers and a host computer database system. A unique electronic ID code is established for each vehicle via the sticker tag and each code is linked to the centralized vehicle database. A back-office violation-processing system automatically generates citations. The EVR also checks commercial vehicle registration and issues citations for those operating in restricted areas during rush hours without a permit.