

# A new view on ITS

ALPR in road traffic is challenged by the extreme variations of sunlight on high-speed targets. Although the artificial vision community has techniques to address these problems, advanced computing platforms are required

**V**ehicle identification using ALPR is a mature technology, with a great deal of success in applications such as access control (for instance, parking lots). In these deployments, the focus is usually on low-speed vehicles in illumination-controllable environments (in the entry of a parking lot, for example). However, new outdoor applications are being challenged by the extreme dynamics of sunlight over high-speed moving targets, from the total darkness at night in inter-urban roads to the extreme sunlight in summertime. Moreover, this variability of light is localized so it is almost impossible to set the right camera parameters for an average measure of illumination.

## A BIT OF GUESSWORK?

Some companies have placed emphasis on creating smart sensors to attempt to guess the light conditions that apply to the vehicle, for instance simulating the reflection of light on a license plate. Unfortunately, these conditions only apply to a subset of vehicles as there are a number of variations that exist which cannot be covered, for instance plates with different reflective materials, different orientations, shadows, and so on.

Another challenge of growing importance is the requirement for free-flow. Modern ALPR systems are supposed to work without external triggering mechanisms, detecting the presence of vehicles from images in real-time. There are different techniques to achieve that goal, from simple movement-



⦿ An example of local variations of illumination



⦿ The FPGA-based Atalaya smart camera has been tailored to meet the demands of the ITS industry

detection algorithms to complex artificial vision techniques that locate the shape of the vehicle. The simplest techniques can detect vehicles at high speed but are too sensitive to variations of light and shadow. The most complex ones are normally too slow and either lose vehicles or introduce indeterminism in relation to the distance from the vehicle to the camera, thereby affecting the size of the plate in the image.

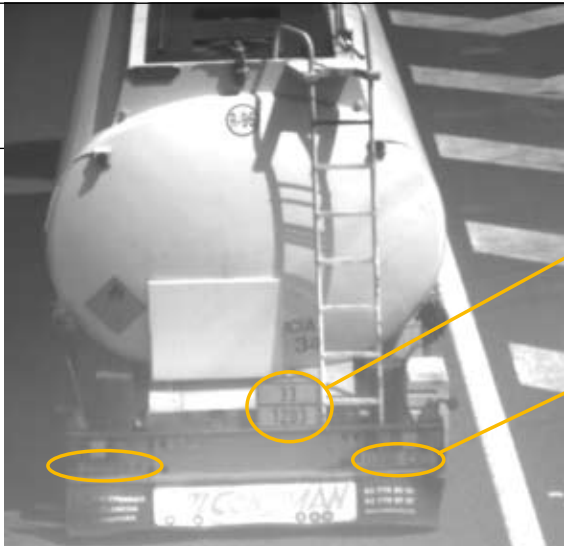
## DILEMMA: RESOLUTION AND SPEED

Another important feature of ALPR systems in road traffic applications is that they require images of much better resolution to cope with the different sizes of vehicles (cars, motorcycles, trucks) and the larger size of the lane. Modern ALPR systems focused on road traffic work with four times the resolution of access control systems. However, the larger the size, the harder the analysis process will be. Algorithms used to

locate the vehicle in an image and read the license plate commonly depend on image size in a quadratic relation – for example, a fourfold increase in resolution requires at least 16 times more effort to get the result. This increase in computing demand conflicts with the current trend in the ITS sector for all-in-one solutions. These new compact systems include all of the elements required for ALPR application in a single housing, to minimize the installation and maintenance costs. But they are usually equipped with embedded CPUs with limited computing power, so can only be used for the less demanding applications in urban areas.

## SUPERCOMPUTING

All of these problems are attractive technological opportunities for companies such as Imagsa, which focuses its attention on high-performance computing artificial vision systems. The company's technical



Above: Full view image



Above: Multi-exposure images

⌚ The technology associated with FPGA devices is combined with high-speed image sensors for accurate license plate recognition



Above: Best candidates

skills include the development of innovative image analysis algorithms and their subsequent implementation into field-programmable gate array (FPGA) devices. These new devices allow for computing speed-ups 100 to 1,000 times faster through the parallel execution of multiple tasks into a single processor.

Imagsa has combined the technology inherent in FPGA devices with high-speed image sensors to develop the Atalaya smart camera family – a compact system optimized for the most challenging road traffic applications in the ITS sector.

**DANGEROUS GOODS TRACKING**

The images on this page show a very challenging application – the control of dangerous goods transportation. This application requires three different license plates to be read on three locations on the truck – one for the vehicle, a second for the trailer, and a third for the goods.

The license plates on the bottom of the vehicle are often much darker than those identifying the goods, so it is extremely difficult to read all three plates in a single image. To solve this problem with an approach independent of sunlight, the Atalaya smart camera takes up to 1,000 images per second with different exposure times and then analyzes them in real-time to obtain one suited for the application.

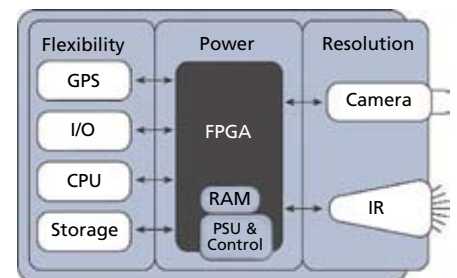
Although this kind of high-speed imaging technique isn't available on standard ALPR systems, parallel computing has helped Imagsa provide a solution. The central



⌚ Atalaya installed for dangerous goods tracking

element of the Atalaya system is an FPGA device connected to a high-speed megapixel camera. Together, they allow the high-speed acquisition and analysis of up to 1,000 images per second in groups of four different exposure times. With this multi-exposure approach, it reads all of the license plates on the vehicle independently of illumination variations – both global variations (day-night) and local variations (shadow-brightness). This technique also allows the best samples of the license plates to be selected, and to normalize them in real-time to maximize the response of optical character recognition (OCR) algorithms.

The sample images are then transferred through a local connection to an embedded



⌚ Atalaya all-in-one system for high-speed LPR

CPU, in which the license plate is finally read with standard OCR tools. As the CPU focuses on the essential amount of pixels without losing the maximum resolution available, Atalaya can obtain a high reliability with a low-cost CPU board on a Windows operating system.

ALPR applications in road traffic environments demand high-performance computing solutions to address the challenges posed by variations of sunlight on high-speed moving targets. As a result of the current trend toward all-in-one systems, the most efficient approach requires the close integration of image sensors to capture images at high frame rates with high-performance computing devices, such as FPGAs. Indeed, to address the computing challenges and to reduce the installation and maintenance costs, this is a prerequisite. ■

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